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Final Programmatic Environmental Impact Statement on

WIND ENERGY DEVELOPMENT

on BLM-Administered Lands in the Western United States

Volume 2: Appendices
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Final Programmatic Environmental Impact Statement on Wind Energy Development on BLM-Administered Lands in the Western United States

Volume 2: Appendices
Volume 3: Comments and Responses

U.S. Department of the Interior
Bureau of Land Management

June 2005

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NOTATION

The following is a list of acronyms and abbreviations (including units of measure) used in this document. Some acronyms used only in tables may be defined only in those tables.

GENERAL ACRONYMS AND ABBREVIATIONS

AWEA	American Wind Energy Association
BLM	Bureau of Land Management
CRADA	Cooperative Research and Development Agreement
DOE	U.S. Department of Energy
DWIA	Danish Wind Industry Manufacturers Association
EERE	Office of Energy Efficiency and Renewable Energy
EIA	Energy Information Administration
ELCC	effective load-carrying capability
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
ESRI	Environmental Systems Research Institute, Inc.
GE	General Electric
GIS	geographic information system
HAWT	horizontal axis wind turbine
IEC	International Electrotechnical Commission
MPDS	maximum potential development scenario
NERC	North American Electric Reliability Council
NREL	National Renewable Energy Laboratory
NWCC	National Wind Coordinating Committee
O&M	operation and maintenance
PEIS	programmatic environmental impact statement
PERI	Princeton Energy Resources International
PTC	Production Tax Credit

R&D	research and development
ROI	return on investment
ROW	right-of-way
RPS	renewable portfolio standard
RSA	rotor-swept area
SCADA	supervisory control and data acquisition
TIO	technology improvement opportunity
TVA	Tennessee Valley Authority
USGS	U.S. Geological Survey
VAWT	vertical axis wind turbine
WECC	Western Electricity Coordinating Council
WindPACT	Wind Partnerships for Advanced Component Technologies
WinDS	Wind Deployment System

UNITS OF MEASURE

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
ft	foot (feet)
ft^2	square foot (feet)
GW	gigawatt(s)
h	hour(s)
ha	hectare(s)
Hz	hertz
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
kV	kilovolt(s)
kW	kilowatt(s)
kWh	kilowatt-hour(s)
lb	pound(s)
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
mi^2	square mile(s)
mph	mile(s) per hour
MW	megawatt(s)
rpm	rotation(s) per minute
s	second(s)
W	watt(s)

ENGLISH/METRIC AND METRIC/ENGLISH EQUIVALENTS

The following table lists the appropriate equivalents for English and metric units.

Multiply	By	To Obtain
English/Metric Equivalents		
acres	0.4047	hectares (ha)
cubic feet (ft^3)	0.02832	cubic meters (m^3)
cubic yards (yd^3)	0.7646	cubic meters (m^3)
degrees Fahrenheit (°F) –32	0.5555	degrees Celsius (°C)
feet (ft)	0.3048	meters (m)
gallons (gal)	3.785	liters (L)
gallons (gal)	0.003785	cubic meters (m^3)
inches (in.)	2.540	centimeters (cm)
miles (mi)	1.609	kilometers (km)
pounds (lb)	0.4536	kilograms (kg)
short tons (tons)	907.2	kilograms (kg)
short tons (tons)	0.9072	metric tons (t)
square feet (ft^2)	0.09290	square meters (m^2)
square yards (yd^2)	0.8361	square meters (m^2)
square miles (mi^2)	2.590	square kilometers (km^2)
yards (yd)	0.9144	meters (m)
Metric/English Equivalents		
centimeters (cm)	0.3937	inches (in.)
cubic meters (m^3)	35.31	cubic feet (ft^3)
cubic meters (m^3)	1.308	cubic yards (yd^3)
cubic meters (m^3)	264.2	gallons (gal)
degrees Celsius (°C) +17.78	1.8	degrees Fahrenheit (°F)
hectares (ha)	2.471	acres
kilograms (kg)	2.205	pounds (lb)
kilograms (kg)	0.001102	short tons (tons)
kilometers (km)	0.6214	miles (mi)
liters (L)	0.2642	gallons (gal)
meters (m)	3.281	feet (ft)
meters (m)	1.094	yards (yd)
metric tons (t)	1.102	short tons (tons)
square kilometers (km^2)	0.3861	square miles (mi^2)
square meters (m^2)	10.76	square feet (ft^2)
square meters (m^2)	1.196	square yards (yd^2)

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APPENDIX A:

U.S. DEPARTMENT OF THE INTERIOR, BUREAU OF LAND MANAGEMENT, INTERIM WIND ENERGY DEVELOPMENT POLICY

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UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
WASHINGTON, D.C. 20240

October 16, 2002

In Reply Refer To:
2800 (WO 350) P
Ref. IB No. 2001-138,
IM No. 2002-011, IM No. 2002-189
and IM No. 2002-196

EMS TRANSMISSION 10/17/2002
Instruction Memorandum No. 2003-020
Expires: 09/30/2004

To: All Field Officials

From: Director

Subject: Interim Wind Energy Development Policy

Program Area: Right-of-Way Management, Wind Energy

Issue: This Instruction Memorandum (IM) provides interim guidance on processing right-of-way applications for wind energy site testing and monitoring facilities, as well as applications for wind energy development projects on public lands administered by the Bureau of Land Management (BLM).

Background: The President's National Energy Policy encourages the development of renewable energy resources, including wind energy, as part of an overall strategy to develop a diverse portfolio of domestic energy supplies for our future. The BLM prepared a National Energy Policy Implementation Plan that included a variety of tasks related to the development of energy resources on the public lands, including renewable energy resources. The Implementation Plan and specific tasks were previously distributed by Information Bulletin No. 2001-138, dated August 15, 2001, and IM No. 2002-011, dated October 12, 2001. While the current contribution of renewable energy resources to our energy supply is relatively small, wind energy and other renewable energy generating sectors of our economy are the fastest growing in the United States. Continued growth in wind energy development will be extremely important in delivering larger supplies of clean, domestic power for America's growing economy.

The United States has significant potential for wind energy development, especially on Federal lands in the west. The recent extension of the Federal wind energy production tax credit and a variety of State-level tax credits and other incentives, including renewable energy portfolio standards in several States, has generated a renewed interest in commercial wind energy projects

on Federal lands. The BLM currently administers some 25 wind energy right-of-way authorizations on public lands in California and Wyoming that encompass a total of approximately 5,000 acres and generate a total of about 500 megawatts of electrical power. The interest in wind energy development has recently increased and new project proposals on public land have been identified in several States. These existing project proposals and future proposals will create a significant workload that will demand a commitment of resources and a priority to the timely and consistent processing of right-of-way applications for the use of public lands for wind energy site testing and monitoring activities and for commercial wind energy development.

Policy/Action:

Inventory and Planning: It is BLM's general policy to encourage the development of wind energy in acceptable areas. Wind energy site testing and monitoring activities are usually in conformance with and can be accommodated by existing land use plans without a need for a land use plan amendment. These existing land use plans identify wilderness and wilderness study areas, Areas of Critical Environmental Concern (ACEC), visual resource management areas, national scenic or historic trails, National Landscape Conservation System units, critical habitat areas, and other special management areas where land use restrictions apply to a variety of uses, including wind energy site testing and monitoring. However, commercial wind energy development activities in some cases may not be in conformance with existing land use plans and it may be appropriate to amend the land use plan as a concurrent action with the same analysis for the wind energy development proposal. In both cases, however, right-of-way applications for wind energy site testing and monitoring or wind energy development projects will be processed in a timely manner.

Wind energy development provides many environmental advantages over other types of energy resource development, however, wind energy development also results in some adverse impacts, including visual resource impacts and wildlife and wildlife habitat disturbance. Wind energy projects also require some infrastructure such as access roads, transmission lines, and other support facilities. Although land use plans combined with appropriate levels of environmental analysis will be used to assess individual wind energy project proposals, the BLM's overall wind energy policy is to minimize negative impacts to the natural, cultural, and visual resources on the public lands. Negative impacts can be minimized by avoiding special management areas with land use restrictions, avoiding major avian (bird) migration routes and areas of critical habitat for species of concern, establishing siting criteria to minimize soil disturbance and erosion on steep slopes, utilizing visual resource management guidelines to assist in proper siting of facilities, avoiding significant historic and cultural resource sites, and mitigating conflicts with other uses of the public lands.

In areas where land use plans are being revised there may be benefits to specifically address wind resource potential, public concerns, and opportunities for wind energy development within the land use planning area. Supplemental planning guidance regarding wind energy and rights-of-way is provided by IM No. 2002-196, dated June 25, 2002. Field Offices are encouraged to

incorporate wind energy resource development potential in these planning efforts to facilitate the processing of future wind energy applications. The land use plan revision process would address the environmental and local community issues associated with commercial wind energy.

This would provide an opportunity to potentially reduce the amount of additional environmental review and documentation required to process a specific application in the future. A programmatic amendment to one or more land use plans could also potentially be used to address wind energy resources on a larger scale.

The BLM and the Department of Energy's National Renewable Energy Laboratory (NREL) have established a partnership to conduct an assessment of wind energy and other renewable energy resources on public lands in the western U.S. The objective of this collaborative effort is to assist in the inventory of high-potential wind energy resources to support BLM land use planning efforts. This GIS-based assessment and analysis information is available through the BLM National Science and Technology Center (NSTC) or available from the Department of Energy internet site (www.eren.doe.gov/windpoweringamerica/where is_wind.html). Information on renewable energy resources, including wind energy, is also available at www.energyatlas.org. Field Offices are encouraged to use this information as the inventory base for addressing wind energy resource development opportunities and to assess the affects of other resource uses on wind energy resources. The National Wind Coordinating Committee also has information available on an internet site (www.nationalwind.org/pubs/permit/permitting2002) that can assist in the permitting and environmental review process associated with wind energy right-of-way applications on the public lands.

The U.S. Fish and Wildlife Service is currently developing guidelines to assist the wind industry in avoiding or minimizing impacts on wildlife by wind energy development. These guidelines contain a procedure for pre-development evaluation of potential wind resource areas based on their impact on wildlife, and recommendations for siting, designing, constructing, and operating wind turbines within areas with wind energy resource potential. A draft of the guidelines will be available in the fall of 2002. The pre-development evaluation procedure was developed by a team of Federal, state, university and industry biologists to rank potential wind development sites in Montana, and is already in use in that area. That process is being modified for use nationwide by the Fish and Wildlife Service. BLM Field Offices will be provided a copy of the guidelines and are encouraged to use this tool when it becomes available for evaluating areas for potential wind energy development.

Applications: All wind energy and wind energy related facilities will be applied for under Title V of the Federal Land Policy and Management Act (FLPMA) and Title 43, Section 2802 of the Code of Federal Regulations (CFR). Wind energy site testing and monitoring will not be authorized by a land use permit under the 43 CFR 2920 regulations. Existing 2920 permits that may have previously been issued will, however, be recognized for the term of the existing permit.

Applications for a right-of-way grant may be submitted for one of the following three (3) types of wind energy projects:

1) a site-specific wind energy site testing and monitoring right-of-way grant for individual meteorological towers and instrumentation facilities with a term that is limited to 3 years;

2) a wind energy site testing and monitoring right-of-way grant for a larger site testing and monitoring project area, with a term of 3 years that may be renewed consistent with 43 CFR 2803.6-5 and the provisions of this IM beyond the initial 3-year term; and

3) a long-term commercial wind energy development right-of-way grant with a term that is not limited by the regulations, but usually in the range of 30 to 35 years.

Applications for any of the above projects will be submitted using Form SF-299, Application for Transportation and Utility Systems and Facilities on Federal Land, consistent with the requirements of 43 CFR 2802.3. The BLM authorized officer should encourage wind energy applicants to schedule preapplication meetings (43 CFR 2802.1) with BLM to assist in the preparation and processing of applications, identify potential issues and conflict areas, identify any environmental or cultural resource studies that may be needed, assess public interest and concerns, identify other authorized uses, identify other general recreation and public uses in the area, discuss potential alternative site locations, and discuss potential financial obligations that the applicant must be willing to assume. Early public notification and involvement of local communities and other interests is also important in increasing public acceptance and avoiding potential conflicts, especially in areas where other uses exist on the public lands.

All wind energy right-of-way applications and authorizations are subject to appropriate cost recovery and rental fees as required by 43 CFR 2808.1 and 43 CFR 2803.1-2. The policy guidance on rental fees contained in this IM is based on comparable payment practices for existing wind energy right-of-way authorizations on Federal and non-Federal lands and was developed in consultation with BLM staff and others with appraisal expertise.

Right-of-way applications for wind energy site testing and monitoring or for wind energy development projects will be identified as a high priority Field Office workload and will be processed in a timely manner. This priority is consistent with the President's National Energy Policy and adequate resources should be provided to review and process the application. The processing time frames for right-of-way applications as required by BLM Manual 2801.35 will be followed for all wind energy applications. Site testing and monitoring right-of-way applications will usually be minor cost recovery category actions and should be processed within a 30-day time frame, consistent with the requirements of the Manual. The Manual requires that the authorized officer notify the right-of-way applicant in writing if processing will take longer, the reasons for the delay, and an estimate of the time frame for processing the application. The BLM Washington Office (WO-350) will also assign a right-of-way Project Manager, if requested by the State Director, to coordinate the processing of any major wind energy development right-

of-way application.

Authorizations:

1) Right-of-Way Grants for Site Specific Wind Energy Testing and Monitoring Facilities: A site-specific right-of-way grant (Form 2800-14) will be used to authorize small individual site-specific meteorological towers and instrumentation facilities. The term of a site-specific right-of-way grant will be limited to 3 years and will not be extended or renewed. Numerous site-specific right-of-way grants for wind energy site testing and monitoring may be issued to various right-of-way holders in the same area and do not establish any exclusive or preferential rights regarding future wind energy development. In addition, the BLM retains the right to authorize other compatible uses of the public lands in the area (43 CFR 2801.1-1(a)(2)).

Rental: The annual rental fee for a site-specific right-of-way grant for wind energy site testing and monitoring will be a minimum of $50 per year for each meteorological tower or instrumentation facility location and include no additional rental fee for the acreage of each site location. The area authorized for these facilities shall be the minimum necessary for construction and maintenance of the temporary facility. Some BLM Field Offices have existing site-location rental fees for temporary facilities on the public lands that can be used for wind energy site testing and monitoring facilities. In some cases these fees will exceed the minimum $50 per year fee. The rental fee for a site testing and monitoring right-of-way grant is paid annually, in advance, on a calendar year basis consistent with the regulations (43 CFR 2803.1-2(a)).

2) Right-of-Way Grants for Wind Energy Site Testing and Monitoring Facilities that Encompass a Site Testing and Monitoring Project Area: A right-of-way grant (Form 2800-14) that includes provisions for renewal beyond the 3-year term (43 CFR 2803.6-5) will be used to authorize wind energy site testing and monitoring facilities that encompass a site testing and monitoring project area. The holder of the site testing and monitoring right-of-way grant retains an interest in the site testing and monitoring project area, but will be required to submit an amended right-of-way application (43 CFR 2803.6-1) and Plan of Development (POD) to BLM for review, analysis, and separate approval for any future wind energy development. The interest retained by the holder of the grant is only an interest to preclude other wind energy right-of-way applications during the 3-year term of the grant. The lands within the grant area will not be available for other wind energy right-of-way applications. The holder of the site testing and monitoring right-of-way grant has established no right to development and is required to submit a separate application to BLM for analysis, review, and decision. The BLM retains the right to authorize other compatible uses of the public lands. The lands involved in the site testing and monitoring right-of-way grant will be defined by aliquot land descriptions and be configured to involve a reasonable amount of land that may support a possible right-of-way application for a wind energy development project in the future.

The site testing and monitoring right-of-way grant for the site testing and monitoring project area will be issued for an initial term of 3 years. This term will be extended or renewed (43 CFR 2803.6-5) only if an amended right-of-way application and POD is submitted for a wind energy development project prior to the end of the 3-year term of the initial grant. The requirement for

submittal of a POD with the amended right-of-way application is consistent with the provisions of 43 CFR 2802.4(h). The holder of the site testing and monitoring right-of-way grant is required to submit, prior to the end of the 3-year term of the grant, an amended right-of-way application for development to retain the interest in the site testing and monitoring project area. (See the Due Diligence section of this IM regarding additional provisions for a site testing and monitoring right-of-way grant.)

Rental: The annual rental fee for a site testing and monitoring right-of-way grant for a site testing and monitoring project area will be based on the total public land acreage of the project area included in the right-of-way grant. The rental fee for the total public land acreage of the grant will be $1,000 per year or $1 per acre per year, whichever is the greater. There is no additional fee for the installation of each meteorological tower or instrumentation facility located within the site testing and monitoring project area. This rental fee is based on the value for the use of the area for site testing and monitoring and the value of the option held by the holder that precludes other wind energy right-of-way applications during the 3-year term of the grant, comparable to similar option payments on private lands. The rental fee for a site testing and monitoring right-of-way grant is paid annually, in advance, on a calendar year basis consistent with the regulations (43 CFR 2803.1-2(a)).

Each type of site testing and monitoring authorization will contain appropriate stipulations, including but not limited to road construction and maintenance, vegetation removal, and number and location of wind monitoring sites. Biological and cultural resource surveys and studies may also be required during the term of the site testing and monitoring authorization to collect information for future resource assessments. A bond is discretionary by the authorized officer (43 CFR 2803.1-4), but will usually not be required for a site testing and monitoring authorization. If a bond is required, the amount of the reclamation bond will consider potential reclamation and administrative costs to BLM.

The wind inventory data collected and held by the right-of-way grant holder is proprietary information and will be protected by the Privacy Act and may be withheld under the Freedom of Information Act to the extent allowed by Federal law. However, sufficient detailed wind data will be required to be provided to the BLM, at the time an amended right-of-way application for development is submitted, to support the environmental analysis and review of the proposed development. This data becomes public information for analysis and decision making purposes related to the processing of the amended right-of-way application for a wind energy development project. Biological and cultural resource studies and data collected by the right-of-way grant holder will also be required to be provided to the BLM and becomes public information to the extent allowed by Federal law.

Site testing and monitoring authorizations may be assigned consistent with the provisions of the regulations (43 CFR 2803.6-3). However, all assignments shall be approved by the BLM authorized officer and the qualifications of all assignees must comply with the Due Diligence

section of this IM and the requirements of the regulations (43 CFR 2802.3(a)(4) and 43 CFR 2802.4(a)(5)). A partial assignment of a site testing and monitoring authorization shall not hinder the BLM management of the authorization or the associated public lands.

3) Right-of-Way Grants for Commercial Wind Energy Development Facilities: A right-of-way grant (Form 2800-14) will be used to authorize all facilities, held by the holder of the grant, on the public lands related to a commercial wind energy development project. This authorization will include the wind turbine facilities, as well as the access roads, electrical and transmission facilities, and other support facilities. The lands involved in the right-of-way grant will be defined by aliquot legal land descriptions and be configured to minimize the amount of land involved, while still allowing an adequate distance between turbine positions and reasonable right-of-way boundaries. In the absence of any specific local zoning and management issues, no turbine shall be positioned closer than five (5) rotor-diameters from the center of the wind turbine to the right-of-way boundary in the dominant upwind or downwind direction, unless it can be demonstrated that site conditions, such as topography, natural features, or other conditions such as offsets of turbine locations warrant a lesser distance. In cases where the applicant holds a long-term lease right on adjacent Federal or non-Federal lands for wind energy development or the adjacent non-Federal landowner provides a setback waiver, this setback requirement may be reduced to 1.5 times the total height of the wind turbine. Further, no turbine shall be positioned closer than 1.5 times the total height of the wind turbine to the right-of-way boundary in any other direction.

The wind energy development right-of-way authorization will contain appropriate stipulations, including but not limited to road construction and maintenance, vegetation removal, a POD for wind turbine installation and operations, wildlife and avian resources mitigation and monitoring, and site reclamation.

The right-of-way holder should also be encouraged, through terms and conditions of the right-of-way authorization, to work with BLM to increase the public acceptance and awareness of the benefits of wind energy development by providing information and public points of access near the development where safe and appropriate. These measures could include footpaths among the turbines, onsite interpretive resources, and photo locations. The BLM and right-of-way holder can provide a positive message on the responsible use of renewable resources and the multiple resource uses of the public lands.

A bond is discretionary by the authorized officer (43 CFR 2803.1-4), but will usually be required for wind energy development right-of-way grants to ensure compliance with the terms and conditions of the authorization and the requirements of the regulations, including reclamation. The reclamation provisions within the POD should include not only removal of turbines and other structures, but also the rehabilitation of access roads and the revegetation of disturbed areas. The amount of the reclamation bond will consider potential reclamation and administrative costs to BLM. Bonds in the amount of $2,500 per wind turbine have recently been required for most wind energy development projects on public lands.

The term of the grant is not limited by the regulations, however, the terms of most existing grants for major wind energy development projects recognize the overall costs and useful life of wind energy facilities (43 CFR 2801.1-1 (h)) and are generally in the range of 30 to 35 years. The grant may be renewed consistent with the provisions of the regulations (43 CFR 2803.6-5). The BLM also retains the right to authorize other compatible uses of the public lands within the right-of-way grant during the term of the grant.

Rental: Rent for commercial wind energy development right-of-way grants will consist of two components: 1) an annual minimum rent and 2) an annual production rent once the project is in commercial production. The rent for any calendar year shall not be less than the minimum rent.

Minimum Rent: The annual minimum rent for a commercial wind energy development right-of-way grant on public land will be $2,365 per megawatt and is based on the total anticipated installed capacity of the wind energy project on public land based on the approved Plan of Development (POD), a capacity factor of 30 percent, a royalty of 3 percent, and an average purchase price of $0.03 per kilowatt hour. These factors only apply to the calculation of the minimum rent and do not establish any basis for the calculation of actual production rental fees during commercial wind energy operations. The minimum rent is a fixed Bureauwide rent based on the following formula:

> Annual minimum rent = (Anticipated total installed capacity in kilowatts as identified in the approved POD) x (8760 hours per year) x (30 percent capacity factor) x (3 percent royalty) x ($0.03 average price per kilowatt hour)

Example for one megawatt (1,000 kW) of anticipated total installed capacity:

> Annual minimum rent = (1,000 kW) x (8760 hours) x (0.30 capacity) x (0.03 royalty) x ($0.03 per kWh) or $2,365 per megawatt of anticipated total installed capacity.
>
> The annual minimum rent will be phased in as follows:
>
> First year - 25 percent of the total minimum rental fee or $591 per megawatt;
> Second year - 50 percent of the total minimum rental fee or $1,182 per megawatt;
> Third year - 100 percent of the total minimum rental fee or $2,365 per megawatt.

The full annual minimum rental fee will apply at any time prior to 3 years, upon the start of commercial operations of the project. The minimum rental fee is paid annually, in advance, on a calendar year basis consistent with the regulations (43 CFR 2803.1-2(a)).

Production Rent: In addition to the minimum rent, a wind energy production rental fee will be required as part of the development right-of-way grant and will apply for any operations greater than the annual minimum rent. The wind energy production rental fee formula will be determined by the authorized officer at the time of issuance of the right-of-way grant using comparative market surveys, appraisals, or other reasonable methods. The site-specific appraisal

will use a percent of gross proceeds methodology based on actual sale prices of electricity and market supported royalty rates. Gross proceeds will include any revenue from the sale of wind energy production from public land, including revenue from the sale of production credits (Renewable Energy Credits). The BLM will discourage the use of a separate "turbine installation fee" (an additional one time payment for each turbine installation) as part of the wind energy production rental fee.

Any production rental fee, above the annual minimum rent, will be paid by the holder of the development right-of-way grant 30 days after the end of the calendar year based on the actual production during the calendar year. The holder of the right-of-way grant shall provide, with the rental payment, documentation of the amount of power produced for the calendar year and evidence of gross income received from that production. Information provided by the holder on compensation provisions of a Power Purchase Agreement or other financial information will be held as proprietary by BLM and will be protected to the extent allowed by Federal law.

All wind energy right-of-way holders are subject to rent in accordance with this IM, unless they are specifically exempt from rent by statute or regulation. Some holders or facilities may be exempt from rent pursuant to the Rural Electrification Act of 1936, as amended (43 CFR 2803.1-2 (b)(1)).

The right-of-way grant may be assigned consistent with the provisions of the regulations (43 CFR 2803.6-3). However, all assignments shall be approved by the BLM authorized officer and the qualifications of all assignees must comply with the Due Diligence section of this IM and the requirements of the regulations (43 CFR 2802.3(a)(4) and 43 CFR 2802.4(a)(5)). A partial assignment of the grant shall not hinder the BLM management of the grant or the associated public lands.

All final decisions issued by the Authorized Officer in connection to the authorization of any of the above described wind energy projects are appealable under 43 CFR part 4 (43 CFR 2804.1(a)). It should also be noted that right-of-way grants are issued as full force and effect decisions (43 CFR 2804.1(b)) and will remain effective during any appeal period.

Competitive Interest: The right-of-way regulations (43 CFR 2803.1-3) provide authority for offering public lands under competitive bidding procedures for wind energy right-of-way authorizations. However, except for the limited competitive procedure identified below, site testing and monitoring or wind energy development right-of-way applications will be processed on a first come basis. The processing of wind energy right-of-way applications on a first come basis is consistent with the President's National Energy Policy and will encourage the access to public lands for renewable energy resource assessments and development. BLM will only initiate a competitive process if a land use planning decision has specifically identified an area for competitive leasing, or if two applicants have current Power Purchase Agreements or Interconnect Agreements with utility transmission providers for a specific project area. If two applicants can provide adequate documentation of current Power Purchase Agreements or

Interconnect Agreements, BLM will actively encourage the applicants to form a joint partnership or cooperative agreement which establishes compatible use of the site between the applicants. If the applicants choose not to form a joint partnership or cooperative agreement, BLM will initiate a competitive process to determine the successful applicant. Competitive bidding will follow the procedures required by the regulations.

As indicated above, wind energy right-of-way applications will be handled on a first come basis. An applicant, however, must submit a complete and acceptable application and provide a cost recovery payment to BLM to establish a priority application. Pending applications will be processed consistent with the guidance provided by this IM prior to the acceptance of new applications for the same lands, unless the new applicant can provide adequate documentation of a current Power Purchase Agreement or Interconnect Agreement. The holder of a right-of-way grant for site testing and monitoring of a site testing and monitoring project area is required to submit, prior to the end of the 3-year term of the grant, an amended right-of-way application for wind energy development to retain an interest in the project area. The lands within the grant area will not be available for other wind energy right-of-way applications. If the holder of the site testing and monitoring right-of-way grant does not submit an amended right-of-way application for development, prior to the end of the 3-year term of the site testing and monitoring right-of-way, the site testing and monitoring right-of-way grant will terminate and the lands will be available for other wind energy applications.

Due Diligence: Some concerns have been raised regarding the potential for land speculators to obtain right-of-way grants and control valuable wind energy resource areas, with the potential to negatively impact the development of wind energy on the public lands. These concerns can be mitigated by applying the applicant qualification requirements of the regulations (43 CFR 2802.3(a)(4) and 43 CFR 2802.4(a)(5)) and requiring certain due diligence provisions in the right-of-way authorization for site testing and monitoring or wind energy development.

The regulations clearly provide authority to require that the application include information on the applicant's technical capability to construct, operate, and maintain the wind energy facilities (43 CFR 2802.3(a)(4)). This technical capability can be demonstrated by international or domestic experience with wind energy projects or other types of electric energy related projects on either Federal or non-Federal lands. The applicant should also be able to provide information on the availability of sufficient capitalization to carry out development, including the preliminary study phase of the project, as well as the site testing and monitoring activities. Actual development or ownership of similar sized wind energy facilities or other types of electric energy related facilities within the last five years by the applicant would generally constitute evidence of financial capability. However, applicants in bankruptcy or other related financial difficulties may not be able to meet the due diligence provisions of the right-of-way authorization. The regulations provide the authority to deny the application if the applicant cannot demonstrate adequate technical ability to construct, operate, and maintain the wind energy facilities (43 CFR 2802.4(a)(5)).

Due diligence is encouraged by the limited 3-year term of the site testing and monitoring right-of-way authorization. The site testing and monitoring right-of-way grant for a site testing and monitoring project area can only be extended or renewed if an amended right-of-way application and Plan of Development is submitted for a wind energy development project prior to the end of the 3-year term of the grant. In addition, the site testing and monitoring authorization and the wind energy development authorization shall include a due diligence requirement for installation of facilities consistent with an approved Plan of Development. If monitoring facilities, under a site testing and monitoring right-of-way authorization, have not been installed within 12 months after the effective date of the authorization or consistent with the timeframe of the approved Plan of Development, the holder shall provide BLM just cause as to the nature of any delay, the anticipated date of installation of facilities, and evidence of progress toward site monitoring activities. If construction of wind energy facilities, under a wind energy development authorization, has not commenced within 2 years after the effective date of the grant or consistent with the timeframe of the approved Plan of Development, the right-of-way holder shall provide BLM just cause as to the nature of any delay, the anticipated date of construction, and evidence of progress toward commencement of construction. Failure of the holder to comply with the due diligence provisions of either the site testing and monitoring authorization or the wind energy development authorization provides the authorized officer the authority to terminate the authorization (43 CFR 2803.4(b)). The rental fee provisions outlined in this IM also mitigate to some extent the concerns regarding due diligence.

Environmental Review:

1) Site Testing and Monitoring Application: The scope of the environmental analysis required by the National Environmental Policy Act (NEPA) for a wind energy site testing and monitoring right-of-way application includes direct, indirect, and cumulative effects of the proposed site testing and monitoring related facilities. The site testing and monitoring right-of-way authorization is for a limited term (3 years) and usually includes only a few wind monitoring towers with instruments attached to measure various meteorological parameters such as wind speed, wind direction, and temperature at various heights above the ground. The footprint for each monitoring tower is small and the need for site clearances should be limited to the areas of proposed surface disturbance and associated areas of potential effect. However, the potential impacts to avian (bird) and bat species from the installation of meteorological towers and associated guy wire supports should be addressed in the environmental analysis. The analysis will require compliance with the requirements of the Endangered Species Act, the Migratory Bird Treaty Act, the National Historic Preservation Act and other appropriate laws.

The environmental review should not address wind energy development facilities, as the installation of wind turbines are not proposed during site testing and monitoring. The reasonable foreseeable development discussions in the environmental analysis for a site testing and monitoring right-of-way application should focus on anticipated installation of additional wind monitoring facilities during the term of the right-of-way grant. Typically only a small number of wind energy site testing and monitoring authorizations ever lead to actual wind energy

development projects. Therefore, the reasonable foreseeable development discussion should not focus on uncertain future development scenarios. However, the cumulative impacts of other wind energy site testing activities and any other reasonable foreseeable activities that potentially impact the same environmental resources in the area are required to be addressed in the environmental analysis.

In some instances, the level of analysis for site testing and monitoring may be completed with a land use plan conformance determination and a Determination of NEPA Adequacy (DNA), rather than a categorical exclusion or environmental assessment record and Finding of No Significant Impact. Guidance on the use of the DNA process for the review of temporary wind energy site testing and monitoring facilities is found in IM 2001-062, dated December 29, 2000.

The holder of a site testing and monitoring right-of-way grant for a site testing and monitoring project area is limited in term to 3 years and the holder is required to submit an amended right-of-way application for any wind energy development project. The right-of-way regulations (43 CFR 2803.6-1) require that the application be submitted and processed consistent with the provisions of 43 CFR 2802 as a separate and distinct application. The holder of the site testing and monitoring right-of-way grant has established no right to development and is required to submit a separate application to BLM for analysis, review, and decision. The proposed wind energy development project will be evaluated upon the submittal of an actual application for the development project. These are not connected actions under the CEQ NEPA regulations (40 CFR 1508.25), as the site testing and monitoring authorization does not automatically trigger any wind energy development project. The site testing and monitoring activities can proceed regardless of whether any future right-of-way application is received for a wind energy development proposal and regardless of any decision that may be made by BLM regarding that application. The site testing and monitoring authorization is independent of any application that may be made in the future for wind energy development.

2) Commercial Wind Energy Development Application: The scope of the NEPA analysis and the compliance requirements with the Endangered Species Act, the Migratory Bird Treaty Act, the National Historic Preservation Act, and other laws for a wind energy development right-of-way application will be broader than a site testing and monitoring application, as the installation of wind turbines, access roads, and electrical transmission facilities will be addressed in the analysis. However, the footprint of wind energy facilities are typically smaller than other types of energy production facilities. The level of site clearances should be limited to the areas of proposed surface disturbances and associated areas of potential effect, including the access roads to wind turbine locations and the electrical transmission and other support facilities. The wind energy development facilities, however, may extend over a large geographic area and have a broad area of influence. The potential impact from these facilities may, therefore, extend beyond the small footprint of the individual wind turbine locations and it may be necessary to provide setbacks from important avian, bat or other wildlife use areas.

The reasonable foreseeable development discussion in the environmental analysis for a development project should focus on the potential for installation of additional wind turbines and increased production and electrical transmission from the project area. In addition, the cumulative impacts of other wind energy projects and any other reasonable foreseeable projects that potentially impact the same environmental resources in the area are required to be addressed in the environmental analysis. A comprehensive Environmental Assessment (EA) will usually be required, however, an Environmental Impact Statement (EIS) may be required if significant public controversy or a determination of significant adverse impacts is made. It may also be possible to combine the required environmental review process for a wind energy development project with applicable State or local environmental procedures for energy facility siting. This would both streamline the process and be consistent with Departmental policy on intergovernmental cooperation.

Although wind energy facilities may not have as significant an adverse impact on surface resources compared to other conventional electrical generation or energy production facilities, there is some concern over adverse noise impacts of rotor blades, visual resource impacts, and potential avian and bat issues. Many of these problems have been resolved or greatly reduced through technological development and the proper siting of wind energy turbines. Potential avian and bat mortality remains a concern of many individuals, however, the use of non-perch towers, new blade designs and reduced rpm rotation has reduced these potential adverse impacts. Raptor impacts from wind energy facilities can be a potential concern. In particular, wind energy turbines located on ridges and upwind slopes can utilize the same updrafts that are commonly used by soaring birds, including but not limited to raptors. Each proposed development site, however, is unique and will require an analysis of avian and bat concentration and movement patterns to determine the potential effects from wind energy development. This analysis should include an examination of the proposed development site to identify major avian and bat feeding, roosting and resting areas, including raptor use areas and Important Bird Areas (IBAs), as well as wetlands, rookeries, and low-level flight paths. This analysis should determine appropriate setbacks to protect these important avian and bat habitats. Care should be taken to identify the ranges and movement patterns of avian and bat species, including threatened and endangered species and other species of management concern. Current information on avian issues is available from the Department of Energy's National Renewable Energy Laboratory (NREL), National Wind Technology Center internet site (www.nrel.gov/wind/avian.html). Information on visual resource management requirements that may assist in addressing wind energy siting issues is available from the BLM National Science and Technology Center (NSTC) internet site (www.blm.gov/nstc/VRM).

LR 2000 Data Entry: A new commodity code (974) has been established to identify wind energy related right-of-way authorizations and to track these uses within LR 2000. Please refer to IM No. 2002-189, dated June 13, 2002, for guidance on the use of this new commodity code.

Time Frame: Effective immediately upon receipt. This interim policy does not apply to wind energy site testing and monitoring authorizations or wind energy development projects authorized prior to the effective date of this IM. However, pending applications and existing wind energy right-of-way authorizations may be amended at the request of the applicant or the holder to include the provisions of this IM. This includes the opportunity for the holder of a right-of-way grant for site testing and monitoring to submit an amended right-of-way application and Plan of Development to BLM for review, analysis, and separate approval for a future wind energy development project consistent with the provisions of this IM. Any amendment of an existing wind energy right-of-way grant that includes an adjustment of rental provisions consistent with this IM, will be effective at the next billing date after the amendment. There will be no refund or credits applied for previous rental payments.

Budget Impact: The application of this interim policy will have some impact on budget. The BLM's proposed FY 2003 budget includes some increased funds for energy related workload, including wind energy, and the development of the FY 2004 budget has identified wind energy workload needs. However, wind energy right-of-way applications are subject to the cost recovery provisions of the regulations and most applications for a development right-of-way will probably meet the criteria for full cost recovery. In addition, BLM monitoring activities are also subject to the cost recovery provisions of the regulations. Workload impacts should be clarified through the streamlined procedures identified by this IM and by the priority established for processing wind energy right-of-way applications. There is also a positive impact through the implementation of consistent procedures in the processing of wind energy right-of-way applications under the existing FLPMA regulations.

Manual/Handbook Sections Impacted: This Instruction Memorandum and policy affect BLM Manual 2801, Right-of-Way Management and Handbook H-2801-1.

Coordination/Contacts: This interim policy was developed with the assistance of a BLM wind energy working group of Field Office representatives and coordinated at the BLM Assistant Director level. BLM State Offices and the U.S. Forest Service were also provided an opportunity to review the policy and provide input prior to finalization. The Department of Energy, National Renewable Energy Laboratory and the BLM National Science and Technology Center provided assistance in addressing technical issues. Wind energy issues have also been the focus of a series of Renewable Energy conferences held by the Department of the Interior and the BLM and also discussions with the Western Governor's Association. The Western State Land Commissioners Association was also provided an opportunity to provide comments on the policy issues. Contacts were also made with wind energy industry representatives and other external groups to discuss wind energy issues.

For Further Information: Any questions concerning the content of this IM should be directed to the WO, Lands and Realty Group 350 and the attention of Ray Brady, Group Manager at (202) 452-7773 or by Email at ray_brady@blm.gov.

Signed by:
Kathleen Clarke
Director

Authenticated by:
Barbara J. Brown
Policy & Records Group, WO-560

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APPENDIX B:

NATIONAL RENEWABLE ENERGY LABORATORY ESTIMATES OF WIND ENERGY RESOURCES ON BLM-ADMINISTERED LANDS

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APPENDIX B:

NATIONAL RENEWABLE ENERGY LABORATORY ESTIMATES OF WIND ENERGY RESOURCES ON BLM-ADMINISTERED LANDS

The U.S. Department of the Interior's Bureau of Land Management (BLM) and the U.S. Department of Energy's (DOE's) National Renewable Energy Laboratory (NREL) have established a partnership to conduct assessments of wind energy on BLM-administered lands in the western United States. An initial assessment of renewable energy potential on BLM-administered lands was published in 2003 (BLM and DOE 2003). This assessment, which looked at an array of renewable resources, including wind, involved the application of various screening criteria to geographic information system (GIS) data for analysis and evaluation of the potential for renewable energy development.

This programmatic environmental impact statement (PEIS) evaluates the potential environmental and socioeconomic impacts associated with wind energy development on BLM-administered lands in 11 western states over the next 20 years (i.e., 2005 through 2025). To determine where potential development might occur on the basis of land status and wind energy resources, NREL constructed a maximum potential development scenario (MPDS) by using the same methodology that was employed for the 2003 renewable energy assessment. NREL used a different model, the Wind Deployment System (WinDS), to project the amount of wind power that might be generated over the next 20 years in the 11-state study area. The projection included an assessment of the potential wind power supply and demand. The WinDS model results were used to define the total number of acres of BLM-administered land that might be economically developable as well as potential economic impacts.

This appendix to the PEIS describes the methodologies NREL used to (1) construct the MPDS, and (2) project the amount of wind power generation over the next 20 years.

B.1 MAXIMUM POTENTIAL DEVELOPMENT SCENARIO

The MPDS was constructed by using the same general methodology that was employed for the 2003 renewable energy assessment. Wind resource data, GIS data, and general screening criteria were used to identify the spatial distribution of the maximum possible extent of future wind energy development activities that might occur on BLM-administered lands over the next 20 years. Maps depicting BLM-administered lands with low, medium, and high potential for wind energy development were constructed for each of the BLM Field Offices in the 11-state study area. These maps are provided at the end of this appendix and are arranged alphabetically by state. An index map showing the Field Office boundaries precedes the maps for each state. The PEIS team used these maps to assess (1) the distribution of BLM-administered lands on which wind energy development activities might be conducted, and (2) the total number of acres that might be impacted.

B.1.1 Wind Resources

The wind resource information used in this analysis was developed and validated by NREL with support from TrueWind Solutions, LLC (now AWS Truewind, LLC) and other wind energy meteorological consultants. The maps were produced from three regional data sets: (1) the Pacific Northwest (Washington, Oregon, Idaho, Montana, and Wyoming) data set produced in 2001 and 2002 at a 1,312-ft (400-m) spatial resolution, (2) the California data set produced in 2002 at a 656-ft (200-m) spatial resolution, and (3) the Southwest (Arizona, Colorado, Nevada, New Mexico, and Utah) data set produced in 2003 and 2004 at a 656-ft (200-m) spatial resolution. Because these data were developed regionally, inconsistencies may exist at regional borders. The regional GIS data can be downloaded from NREL (2004). More detailed information about the validation of the regional wind resource data sets can be obtained from Elliott and Schwartz (2002).

Wind resources are assigned to seven different power classes on the basis of their resource potential. Table B-1 lists the characteristics of each power class, and Figure B-1 shows the distribution of wind resources across the United States.

B.1.2 GIS Data

GIS-based land jurisdiction data identifying BLM-administered lands and Field Office boundaries were provided by the BLM's National Science and Technology Center. They were

TABLE B-1 Wind Power Classification

Wind Power Class	Resource Potential (Utility scale)	Wind Power Density (W/m^2) at 164 ft (50 m) above Ground Level	Wind Speed[a] (mph) at 164 ft (50 m) above Ground Level
1	Poor	0 – 200	0.0 – 12.5
2	Marginal	200 – 300	12.5 – 14.3
3	Moderate	300 – 400	14.3 – 15.7
4	Good	400 – 500	15.7 – 16.8
5	Excellent	500 – 600	16.8 – 17.9
6	Excellent	600 – 800	17.9 – 19.7
7	Excellent	> 800	> 19.7

[a] Mean wind speed is estimated by assuming a sea level elevation and a Weibull distribution of wind speeds with a shape factor (k) of 2.0. The actual mean wind speed may differ from the estimated values shown here by as much as 20%, depending on the actual wind speed distribution (or Weibull k value) and elevation above sea level.

Source: Elliott et al. (1987).

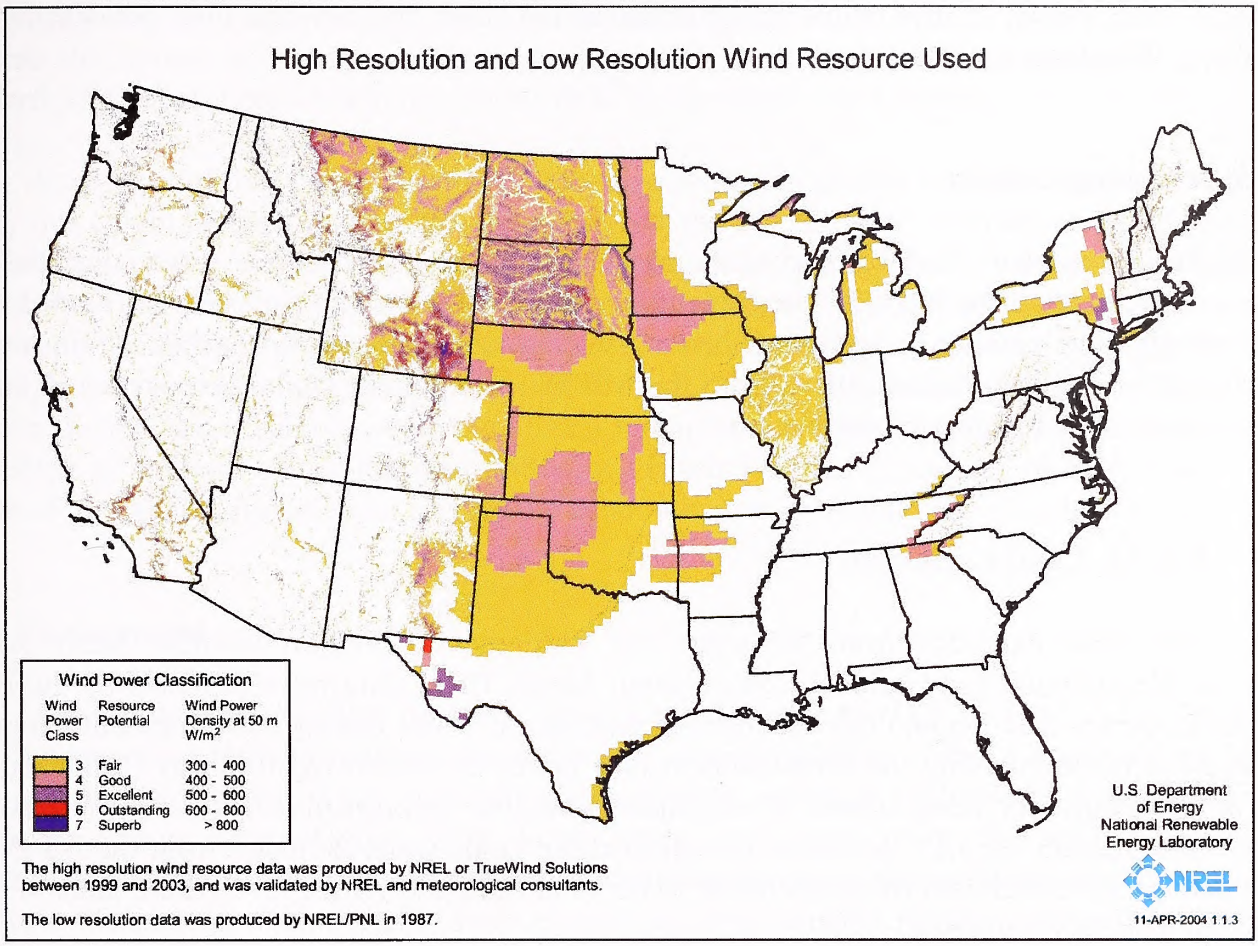


FIGURE B-1 Wind Resource Distribution Map

used to define the distribution of lands within the 11-state study area. In addition, GIS data depicting major cities and towns, major roads, and transmission lines were assembled as follows:

- *Major cities and towns*. The major cities and towns included on the maps were chosen to provide reference points throughout the mapped region. Population was one factor in choosing a city for display, but more important was the distribution across the region. These data were obtained from Environmental Systems Research Institute, Inc. (ESRI 2004).

- *Major roads.* The major roads included on the maps are state and federal highways. These data were also obtained from ESRI (2004).

- *Transmission lines.* The transmission line data included on the maps were extracted from POWERmap, ©2003 (Platts, Inc. 2004a), a national-level GIS data product marketed by Platts, Inc. The maps show all existing transmission lines present in the POWERmap data set, categorized by voltage. The data set has consistent coverage of lines that are 100 kV and higher throughout the 48 contiguous states. The lower-voltage lines that are covered in this data set

are shown on the maps; many transmission lines that are less than 100 kV, however, are missing.

B.1.3 Screening Criteria

The assembled wind resource data and GIS data described above were compiled and screened to construct the MPDS. The screening criteria were used to find lands excluded from wind energy development by virtue of their status, classification, or some other administrative determination and to eliminate them from the MPDS. In addition, lands were screened on the basis of their wind resource classification.

B.1.3.1 Land Exclusions

The areas excluded from the maps are Wilderness Areas, Wilderness Study Areas, National Monuments, and National Conservation Areas. These data were provided by the BLM National Science and Technology Center. As part of the Wind Energy Development Program, the BLM is recommending the establishment of a policy by which right-of-way (ROW) grants will not be issued for lands where development would be incompatible with specific resource values (see Section 2.2.3.1). Although not all of these lands were excluded from the MPDS, in large part because such identification needs to occur at the Field Office level, these lands will be excluded from development.

B.1.3.2 Wind Resource Screening Criterion

BLM-administered lands were categorized into areas having a low, medium, or high potential for development over the next 20 years on the basis of their wind power classification. Lands categorized as having low potential fall in wind power Classes 1 and 2. Lands with a medium potential fall in wind power Class 3. Lands with a high potential fall in wind power Class 4 and higher. Wind resources in Class 4 and higher are generally considered to be economically developable with current technology. Class 3 wind resources are expected to become more economical when low-wind-speed turbines, which are currently in development, become available. In some areas, a Class 3 wind resource may be economical when current technology is used, depending on project-specific financing and incentives.

B.2 WinDS MODEL ANALYSES

The WinDS model is a multiregional, multi-time-period, GIS and linear programming model of capacity expansion in the U.S. electric sector. WinDS is designed to address the principal market issues related to the penetration of wind energy technologies into the electric sector. These principal market issues include access to transmission, the cost of transmission, and the intermittency of wind power. WinDS addresses these issues by implementing a highly discretized regional structure, explicitly accounting for the variability in wind output over time,

and considering the requirements and costs of ancillary services. WinDS also can be used to examine the impact of various policy initiatives, such as federal and state renewable portfolio standards (RPSs) and production tax credits (PTCs), on future wind capacity.

In support of this PEIS, the WinDS model was used to project the amount of wind energy supply that might be economically developable over the 20-year study period (i.e., 2005 through 2025) in each of the 11 western states included in the scope of analysis. From this projection, the total number of potentially economically developable acres of BLM-administered lands was calculated. The WinDS model was also used to project the portion of total electricity demand that might be met by wind energy power. The model results were analyzed within the GIS to estimate the amount of supply in each state that might be developed on BLM-administered lands by looking at the land ownership distribution of the wind resource assigned in each region. The results of the WinDS model were used in the economic impact evaluation in Section 5.1.13.

B.2.1 Background

Several models exist that forecast capacity expansion in the U.S. electric sector. Many of these models were built to address the entire U.S. energy market, with its emphasis on fossil fuels and nuclear energy. Thus, although these models generally include the more prominent renewable energy technologies, their large scope and their focus on today's dominant conventional energy forms do not allow for a detailed treatment of the more important issues that pertain to wind energy technologies. For example, in many existing models, conventional energy technologies can be adequately captured by regionally disaggregating to the 13 North American Electric Reliability Council (NERC) regions and subregions. However, at this level of regional aggregation, the models cannot capture the transmission requirements that are unique to wind, because they assume that the resource is next to the load.

The WinDS model is designed to represent the most significant market issues pertaining to wind energy. These include issues related not only to the transmission but also to the intermittency impacts of wind on grid ancillary service requirements. By explicitly addressing these issues, WinDS is able to remove many of the constraints caused by large regions that the other models impose on wind energy.

B.2.2 Model Description

B.2.2.1 Structure

WinDS models the expansion of generation and transmission capacity in the U.S. electric sector over the next 50 years. It minimizes systemwide costs of meeting loads, reserve requirements, and emission constraints by building and operating new generators and transmission in each of 25 2-year periods from 2000 through 2050. It considers a wide range of generator types, including natural gas combined-cycle generation, natural gas combustion turbines, gas and oil steam generation, several coal-fired generator options, nuclear power,

hydroelectricity, wind, and other renewable electricity technologies (e.g., landfill gas, concentrating solar power, biopower).

The core of the WinDS model is a linear programming optimization of the expansion of the electric sector's capacity in each 2-year period. However, much of the data that are input to this optimization are derived from a detailed GIS model/database of the wind resource, transmission grid, and existing plant data. The GIS utilizes updated wind resource assessments validated by NREL (2004), and it excludes resource areas that may be environmentally sensitive or unlikely to be developed because of their ownership, designation, land use, or physical attributes (see Table B-2). In addition, a 2-mi (3-km) area surrounding lands that are completely excluded from development and small, isolated wind resource areas with a low likelihood of utility-scale development are also excluded. These wind resource exclusions differ significantly from the MPDS exclusions (see Section B.1.3). The exclusions used in the MPDS are used to define the maximum potential, whereas the exclusions used in WinDS are intended to better represent areas that are likely to be available for wind development. Transmission lines and power plant locations are extracted from POWERmap. The WinDS model utilizes regions that were created within the GIS from county boundaries. The geographically summarized information and other inputs are transferred to the optimization through a spreadsheet input interface. The results from the optimization are output through a similar spreadsheet interface, facilitating the review and production of graphical output.

One of the unique features of WinDS is its regional discretization of the U.S. electric sector. (See Figure B-2 for a map of all regional levels.) At the highest level, it distinguishes among the three major synchronized interconnections within the United States: (1) Eastern interconnect, (2) Texas (basically the Electric Reliability Council of Texas [ERCOT]), and (3) Western interconnect (basically the Western Electricity Coordinating Council [WECC]). Below the interconnection level, it considers ancillary service requirements at the NERC region and subregion level (13 regions in the continental United States). Capacity expansion decisions are made one level lower for 134 power control areas. Finally, wind power is supplied from 356 wind regions (NREL 2004). The fine regional disaggregation of wind supply allows WinDS to calculate transmission distances and the benefits of dispersed wind farms supplying power to a demand region.

WinDS is also disaggregated with respect to time. Within each year, dispatch decisions are made separately for four different load levels in each of the four seasons. Although data are currently sparse, WinDS accounts for the variation in wind output in these different time "slices" within each wind supply region. The time disaggregation not only helps in capturing the correlation between wind output and loads but is also important in capturing the dispatching of peaking units, spinning reserve requirements, transmission loading, etc.

WinDS disaggregates the wind resource into five classes ranging from Class 3 to Class 7 (Figure B-1). The amount of each class of wind available within each of the 356 wind supply regions (along with the capacity factor for each class, in each region) is derived by means of the GIS capability and input to the optimization. In addition, the GIS capability supplies the optimization with a supply curve for the cost of building access from each wind site within a

TABLE B-2 Land Exclusion Criteria Used in the WinDS Model

Category	Description
Ownership	All National Park Service lands
	All U.S. Fish and Wildlife Service lands
	50% of U.S. Forest Service lands[a]
	50% of U.S. Department of Defense lands[a]
Designation	National Parks
	Wilderness Areas
	Wilderness Study Areas
	Wildlife Refuges
	Wildlife Areas
	National Recreation Areas
	National Battlefields
	National Monuments
	National Conservation Areas
	Wild and Scenic Rivers
	All state and private lands in the highest protection category and 50% of state and private lands in the second-highest protection category[b]
Land use	Urban areas
	Airports/airfields
	Wetlands
	Water bodies
Physical attributes	Slope[c]
	Terrain[d]
	Forest terrain type[e]
Other	2-mi (3-km) buffer[f]
	Wind resource density[g]

[a] Fifty percent of lands owned by this agency not already excluded by virtue of designation are excluded to account for probable competing land uses.

[b] Based upon protection categories assigned by the U.S. Geological Survey (USGS) Gap Analysis Project (USGS 2004). Data were not available for all states.

[c] Slopes >20% are excluded on the high resolution wind resource datasets.

[d] Terrain exposure factors of 5% (ridgecrest), 35%, 65% and 90% (relatively flat areas) are from Elliot et al. (1987).

[e] Fifty percent of nonridgecrest forest areas are excluded to reflect the additional efforts that may be necessary for development on forested lands.

[f] An additional 2-mi (3-km) area surrounding National Park Service lands, U.S. Fish and Wildlife Service lands, and areas excluded by designation or land use is excluded.

[g] Isolated wind resource areas that would be less attractive for wind farm development are excluded. A criterion of 2 mi^2 (5 km^2) within the 100-km^2 area surrounding a Class 3 or higher resource is used to exclude these areas.

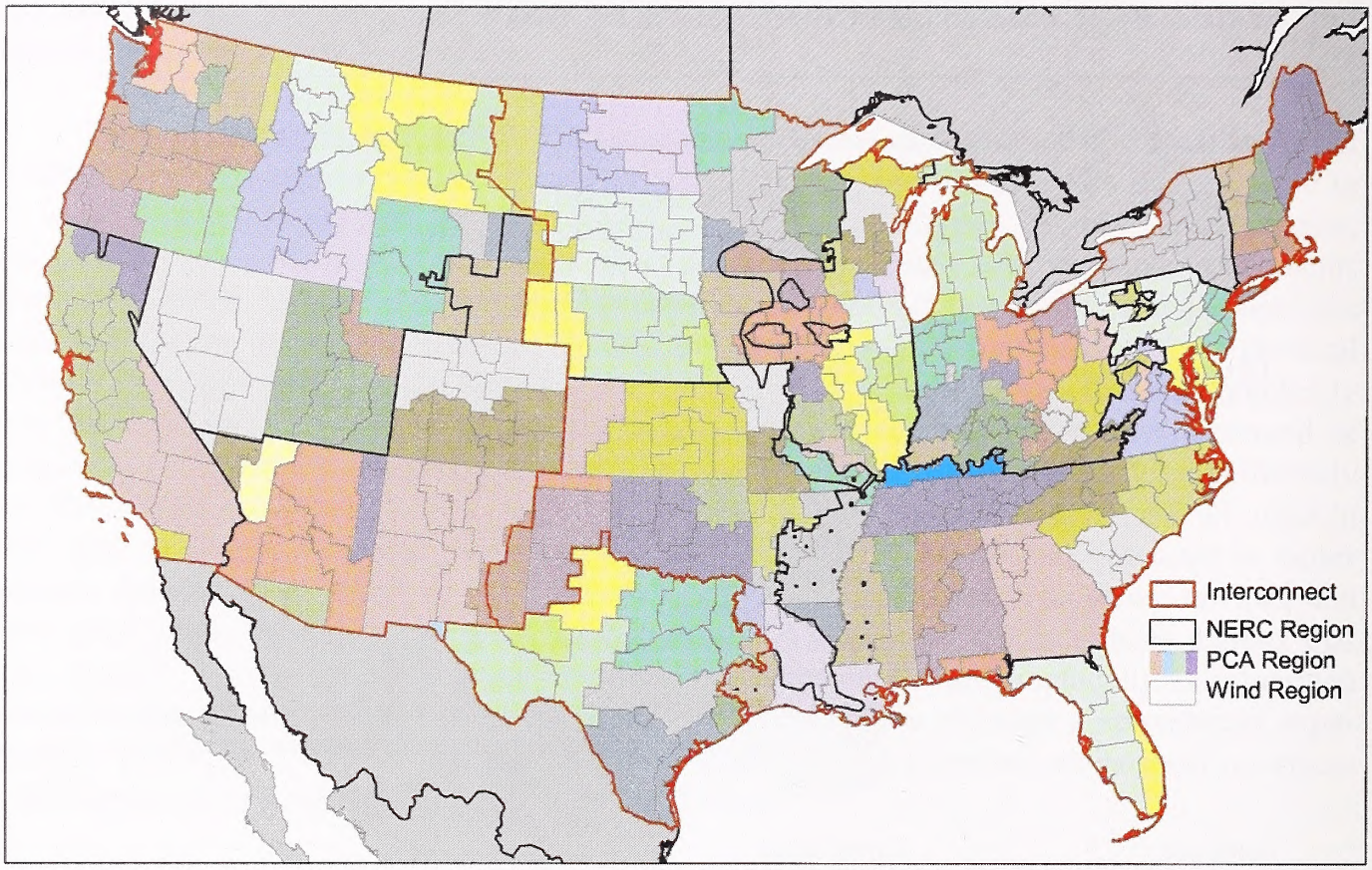


FIGURE B-2 Regions within WinDS

region to an available transmission line within the existing grid. The GIS provides a second supply curve for the cost of building access directly from the wind sites to the load centers in the same region for use when the cost to access the grid is too high.

The WinDS model estimates the amount of wind power that will be generated. These estimates can be converted to an estimated number of acres developed on the assumption that 1 MW of power requires approximately 50 acres (20 ha) of land.

B.2.2.2 Objective Function

The driver in any optimization is the objective function. In WinDS, the linear program minimizes the total cost of providing power for the next 20 years by deciding which generators and transmission lines should be built in the current 2-year period and how they should be dispatched. The costs to be minimized are:

- Present value of the cost of both generation and transmission capacity installed in this period,

- Present value of the cost of operating that capacity during the next 20 years (fixed and variable operation and maintenance [O&M] and fuel costs) to meet load or for spinning reserve, and

- Cost of reserve capacity.

The capital costs for new-generation equipment change over time according to direct user specifications on input or on the basis of a learning curve. For new generators, the user can also define the O&M costs, fuel costs, heat rates, and wind capacity factors as they change over time. Financing can be explicitly modeled by using either corporate financing or project-specific financing, with the consequent debt service coverage requirements. Depreciation for income tax purposes and federal tax credits are explicitly accounted for. Escalation of fuel prices over time can be input.

Costs for transmitting wind on existing lines consist of the capital cost to build a new line from the wind site to the grid and a service charge per megawatt-hour to use the existing lines. The capital cost of a new line is a linear function of the number of megawatts that the line must be able to carry and the length of the line. Lines built to transmit wind are assumed to do so exclusively (i.e., only wind is carried on the line). Thus, the cost of such lines is amortized over the relatively low capacity factor of wind.

B.2.2.3 Constraints

The cost of capacity expansion and operation in the electric sector is minimized in each of the 2-year optimization periods subject to a set of constraints. The principal constraints are described briefly here.

Wind resources. The total amount of wind energy capacity that can be developed in each of the 356 wind supply regions is constrained to be less than the wind resources shown in Figure B-1.

Wind access to existing transmission lines. There are several constraints on the use of existing lines to transmit the electricity from new wind installations.

- For each of the five classes of wind within each of the 356 wind supply regions, a GIS is used to develop a small supply curve for the cost of building a transmission line from the wind site to the existing grid. Because the GIS program considers the load on the existing grid transmission lines (a user input) and the amount of wind from other sites that is on the grid line, the length of this connecting line is typically much more than the shortest distance to the existing grid.

- In the linear programming optimization for each 2-year time period, the amount of wind energy that can be developed and connected to existing lines is constrained by the transmission cost supply curve developed by the GIS (see paragraph directly above).

- When the cost to reach the grid is excessive, the optimization may elect to build a new transmission line from the wind in a region to load centers in the same region. The GIS also provides a supply curve for this purpose.

- The amount of wind transmitted to meet the demand in another one of the 356 wind supply regions is limited to the available capacity on the transmission lines entering the destination region.

Load. The primary load constraint is that the load in each power control area must be met in each time slice throughout a year. The load is assumed to increase exponentially from one year to the next according to the user inputs. The load in a given power control area can be met by either (1) generation from conventional technologies or wind generation within the power control area, or (2) power transmitted from other power control areas or wind supply regions. Wind generation in a given time slice is determined by the wind capacity available and the capacity factor for that time slice. The model dispatches conventional generation to minimize total costs while meeting the load constraint.

There is a secondary load constraint on wind. To better estimate the transmission distance required for wind, WinDS actually tracks the delivery of wind to demand subregions within the power control area. These demand subregions have the same geographic boundaries as the wind supply areas. WinDS does not allow the wind shipped from one wind supply region to a demand subregion (a different wind supply region) to exceed some user-specified fraction of the peak load in the demand subregion. This ensures that all the wind is not simply sent to the closest demand subregion. The peak load of a demand subregion is the peak load in the power control area to which it belongs multiplied by the fraction of the power control area population that is within the demand subregion.

Reserve. There are two types of reserve constraints: the planning reserve margin and operating reserve. These constraints require the calculation of the variance in the wind output from all the wind supply regions contributing to the demand region. This wind output variance is calculated by explicitly considering the dispersal of wind farms. If two wind farms are far apart, their output will be less correlated than the output from two farms that are contiguous to one another. WinDS assumes that the amount of correlation between the output of any two wind farms is proportional to the distance between the two wind farms. Thus, the variance in the total output from the two separated farms will be less than that of the two contiguous farms. This reduced variance for dispersed wind farms leads to a higher wind capacity value and less need for reserve. The variance in output from all the wind generation is recalculated at the end of each 2-year optimization period and used to calculate the coefficients on wind in the linear reserve constraints for the next 2-year period.

The planning reserve margin constraint is applied to each NERC region. It requires that the conventional capacity within the region, plus the product of the wind nameplate capacity, multiplied by an effective load-carrying capability (ELCC) for the wind, exceed the peak load of the interconnection plus a reserve margin. The wind ELCC is the amount of additional load that can be met by the addition of one more megawatt (1 MW) of wind capacity without changing the reliability of the grid. It is based on stochastic calculations of the loss-of-load probability (LOLP) that use the variance in wind output.

The operating reserve constraint is applied at the NERC region/subregion level. It captures the need for reserves to meet both contingencies (generation- and transmission-forced outages) as well as short-term (10 to 30 minutes) load-following requirements. These reserve requirements can be met by spinning reserves from hydroelectric facilities and combustion turbines, quick-start capacity, and interruptible loads controlled by the electric distribution company. Because the conventional generation that contributes to operating reserves can occur in different states (generating or idle) in different time slices (peak, off-peak), the operating reserve requirement is applied to each time slice within a year. Wind generation can increase the need for operating reserves because wind generation can unexpectedly increase or decrease. However, the changes in wind generation are not correlated with the conventional capacity contingency requirements or load changes. Thus, the additional operating reserve requirements due to wind are not proportional to the amount of wind but rather to the variance in the sum of the normal operating reserve and the amount of reserve that can be met by wind generation. In effect, this means that the operating reserves induced by wind per unit of wind capacity are generally low initially and can grow quickly if significant numbers of wind farms are installed close to one another (i.e., with highly correlated generation).

Wind-generated electricity that is lost because it is surplus is also accounted for within WinDS at the interconnection region level. When demand is low and the wind is blowing, there can be times when all the wind generated is not used. WinDS uses the variance of the sum of all wind generation, together with a load duration curve and the forced outage rates of conventional technologies, to stochastically compute the expected amount of wind that cannot be used. This surplus wind is calculated after each period's optimization and used in the next period to reduce the amount of generation contributed by wind (and effectively to increase the cost of new wind power).

Emissions. At the national level, WinDS has the ability to cap the air emissions of sulfur dioxide, nitrogen oxides, mercury, and carbon from fossil-fueled generators. For this analysis, only sulfur dioxide emissions are capped at the levels specified by the Clean Air Act Amendments.

B.2.2.4 Variables

By minimizing the objective function cost subject to the constraints described above, WinDS endogenously calculates the following variables for each time period:

- Wind capacity installed in each wind supply region,
- Wind generation transmitted from each wind supply region to each demand region by existing transmission lines,
- Wind generation transmitted from each wind supply region to each demand region by new transmission lines,
- New transmission lines built to transmit wind from supply regions to demand regions,
- Conventional capacity by type installed in each power control area,
- Conventional generation by type dispatched in each power control area in each time slice within a year,
- Transmission built in each year to transmit power between power control areas,
- Power transmitted in each time slice in each year between power control areas,
- Interruptible load under contract in each power control area, and
- Spinning reserve operating in each time slice within a year in each NERC region.

B.2.3 Standard Assumptions

The WinDS base case is a business-as-usual case that relies heavily on the reference case scenario of the DOE Energy Information Administration (EIA) *Annual Energy Outlook 2004* (DOE 2004) to determine inputs that fall outside the scope of WinDS. These inputs include electricity demand, fossil fuel prices, existing federal energy policies, and the cost and performance of nonwind electricity-generating technologies.

Onshore wind-power cost and performance data in the WinDS base case are derived from projections made in 2002 by Princeton Energy Resources International (PERI) for the DOE Wind Program (Short 2002). In the base case, it is assumed that only one-half of the projected capacity-factor improvements and one-third of the cost improvements will occur through research and development (R&D). Table B-3 shows the resulting R&D-driven cost and performance improvements used in WinDS for the base case. In addition to allowing for the improvements over time shown in Table B-3 for the base case, WinDS also allows for "learning" improvements in both the costs and capacity factors. For each doubling of installed worldwide wind capacity (a scenario of wind installations outside the United States reaching 130 GW by

TABLE B-3 Base-Case R&D-Driven Wind Costs and Performance

Wind Class	Year	Capacity Factor	Capital Cost ($/kW)	Variable O&M (mil/kWh)[a]
4	2005	0.29	916	3.8
4	2010	0.35	914	3.7
4	2020	0.36	899	3.6
4	2030	0.36	899	3.6
4	2040	0.36	899	3.6
4	2050	0.36	899	3.6
6	2005	0.42	880	3.8
6	2010	0.45	880	3.7
6	2020	0.47	864	3.6
6	2030	0.47	864	3.6
6	2040	0.47	864	3.6
6	2050	0.47	864	3.6

[a] A mil equals a thousandth of a dollar.

2030 is input to WinDS), there is an 8% reduction in capital costs, and the capacity factor gets 8% closer to the projected PERI/NREL values. Table B-4 summarizes these and many of the other critical parameters used in the WinDS base case and also in this PEIS.

B.2.4 WinDS Model Application for Wind Energy Development PEIS

The data presented in Table B-4 make up the standard set of data that NREL used in its base case for all its analyses in early 2004. No input parameters were changed for this PEIS analysis, except that it was assumed that the PTC would be extended to the end of 2006. The U.S. Congress is seriously considering extending the PTC for wind energy that expired at the end of 2003. As proposed in the Corporate Tax Bill (S. 1637), the 1.8 cents/kWh PTC would be extended to the end of 2006. (It would also be expanded to cover other renewable technologies.) The WinDS model was run with the base-case data from above and with a tax credit of 1.8 cents/kWh for each kilowatt-hour of electricity produced in the first 10 years of production by wind plants built before 2007.

For this analysis, the base-case wind capacity results, including the PTC extension until 2006, were summed across all the wind supply regions in each state to determine the total wind installations by state. To estimate the fraction of the wind capacity installed on BLM lands in each state, the wind capacity results by region and 2-year time step were transferred back into the GIS. The GIS was used to disaggregate the wind capacity results at the wind region level back

TABLE B-4 Primary Data in the WinDS Base Case and PEIS Analysis

Parameter	Source or Value
Electricity loads	DOE (2004), reference case extrapolated to 2050
Fossil fuel prices	DOE (2004), reference case extrapolated to 2050
Wind cost/performance	Reduced DOE Wind Program goals
Wind resources	NREL internal data
Conventional plant cost/performance	DOE (2004), reference case extrapolated to 2050
Conventional plant sizes and locations	RDI BASECASE GIS data (Platts, Inc. 2004b)
Fossil fuel generation emissions	U.S. Environmental Protection Agency E-grid database (EPA 2004)
Financial analysis period	20 years
Real discount rate (weighted cost of capital)	8.5%
Combined marginal income tax rate	40%
Depreciation schedule for tax purposes	MACRS (Modified Accelerated Cost Recovery System, a provision of the Internal Revenue Service tax code)

down to the resource data level that was used to construct the wind-transmission supply curves for WinDS. The specific wind sites developed in each region were estimated to be those sites in the portion of the supply curve that was accessed by WinDS. Once the sites were known, their ownership was determined by using the BLM land status data set obtained from the BLM National Science & Technology Center in 2002.

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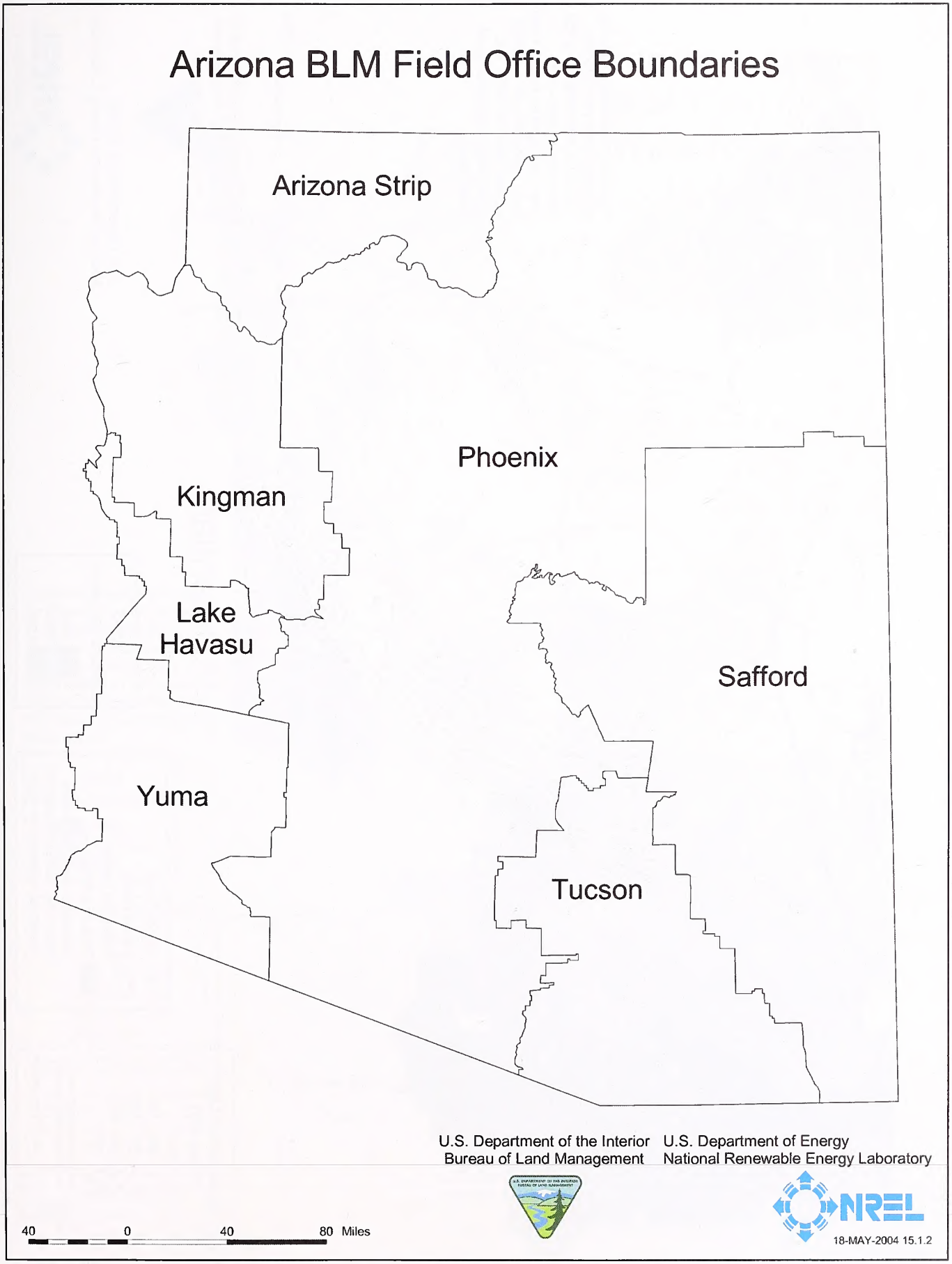
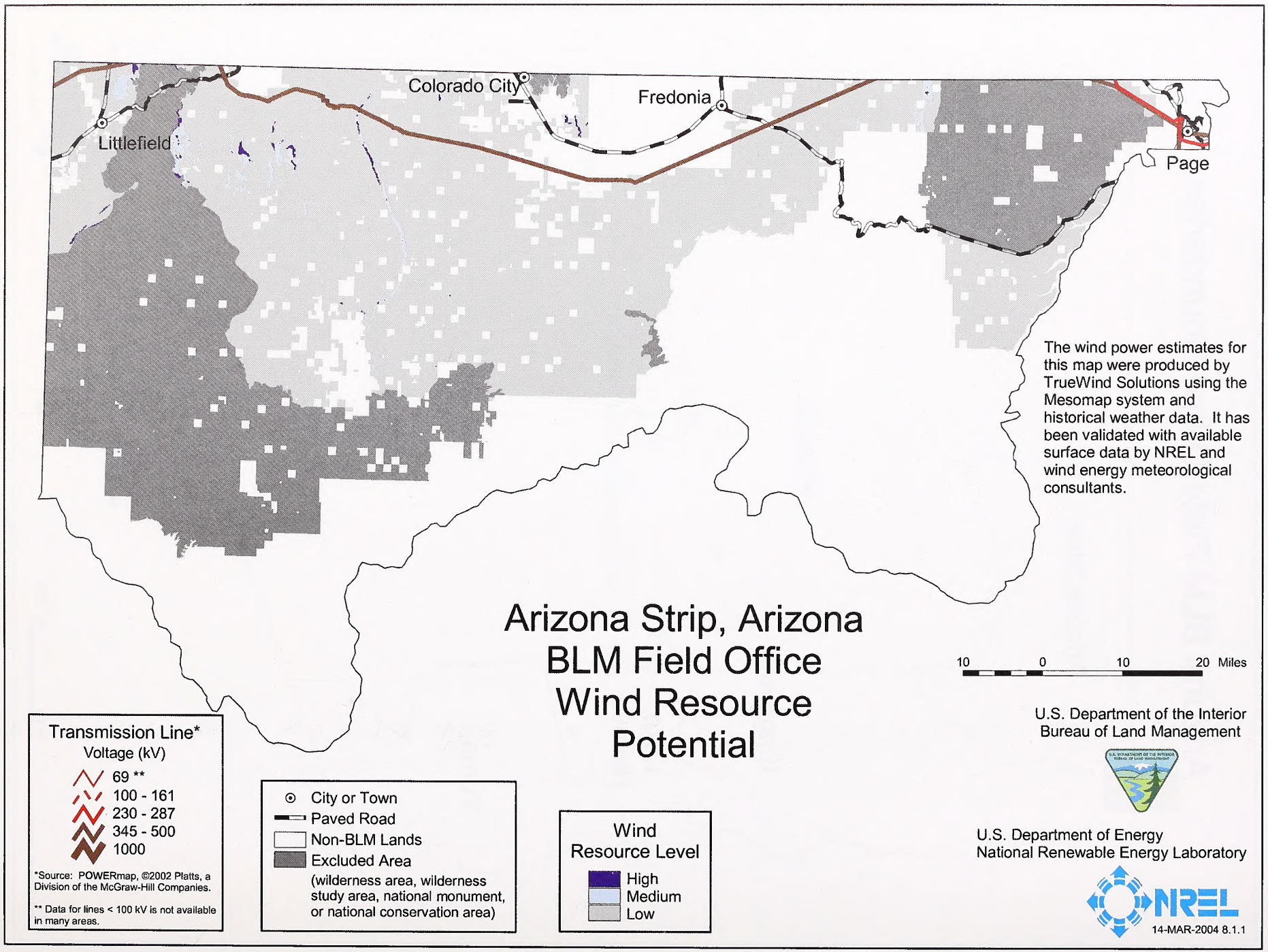
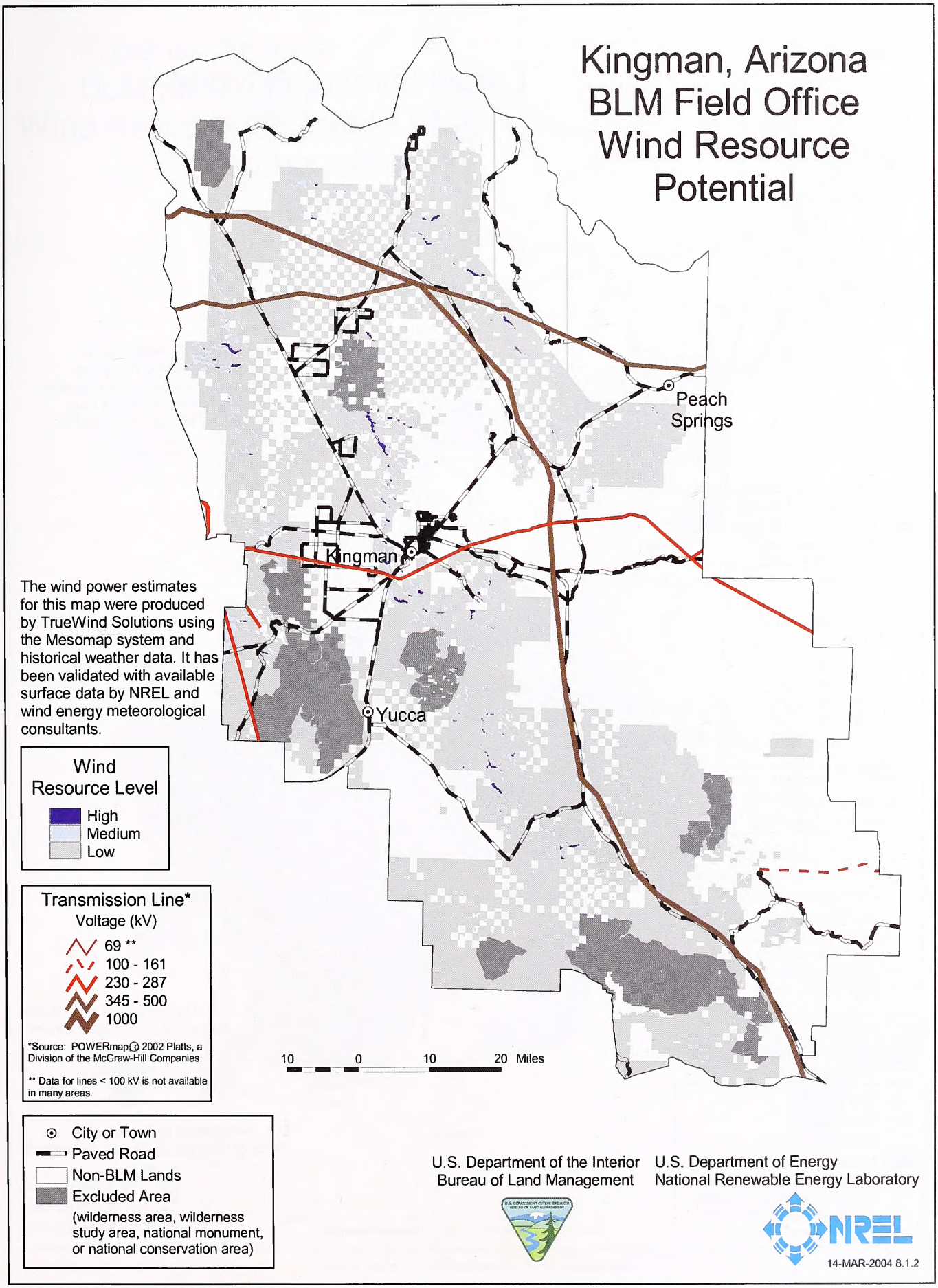
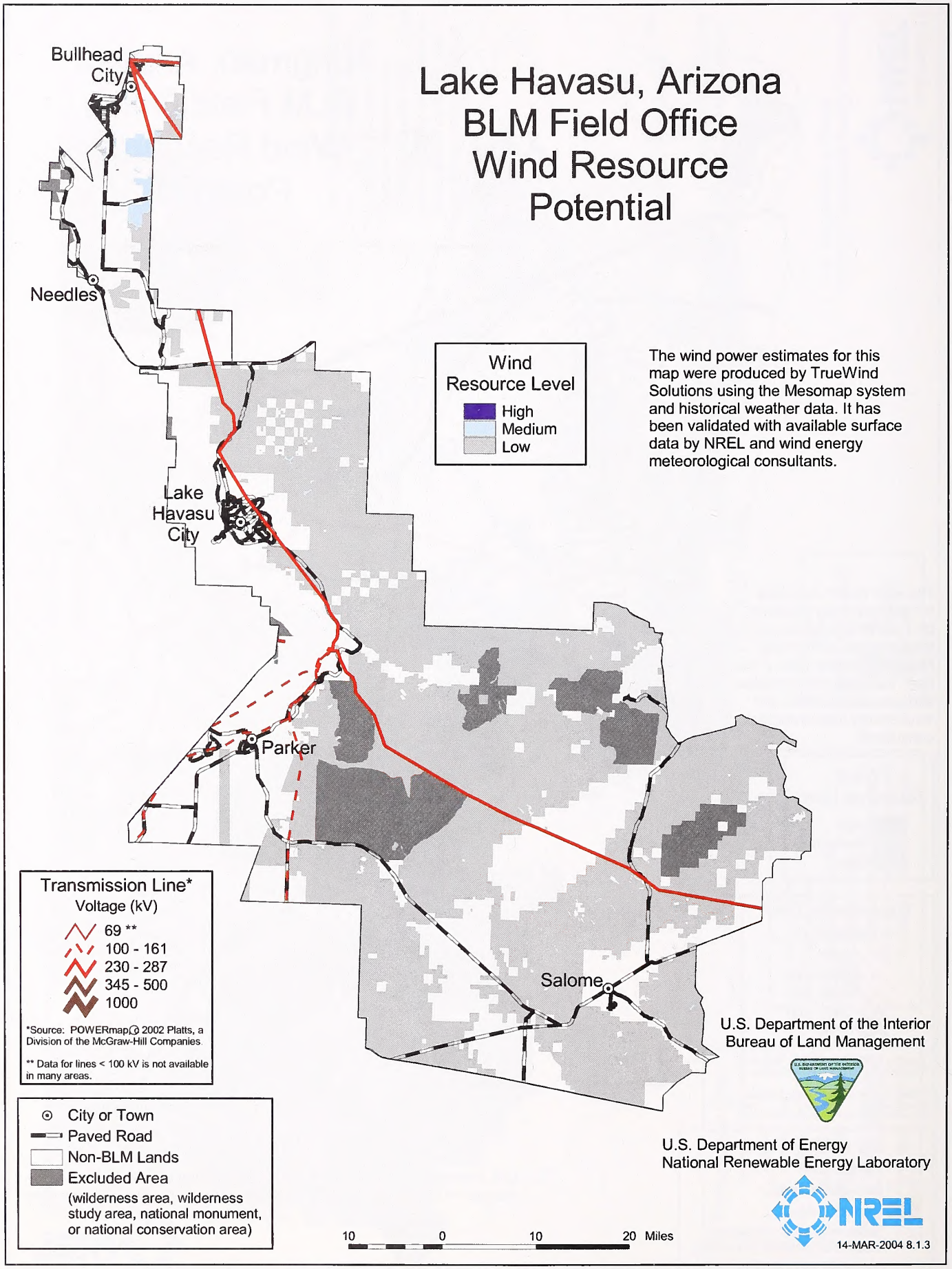
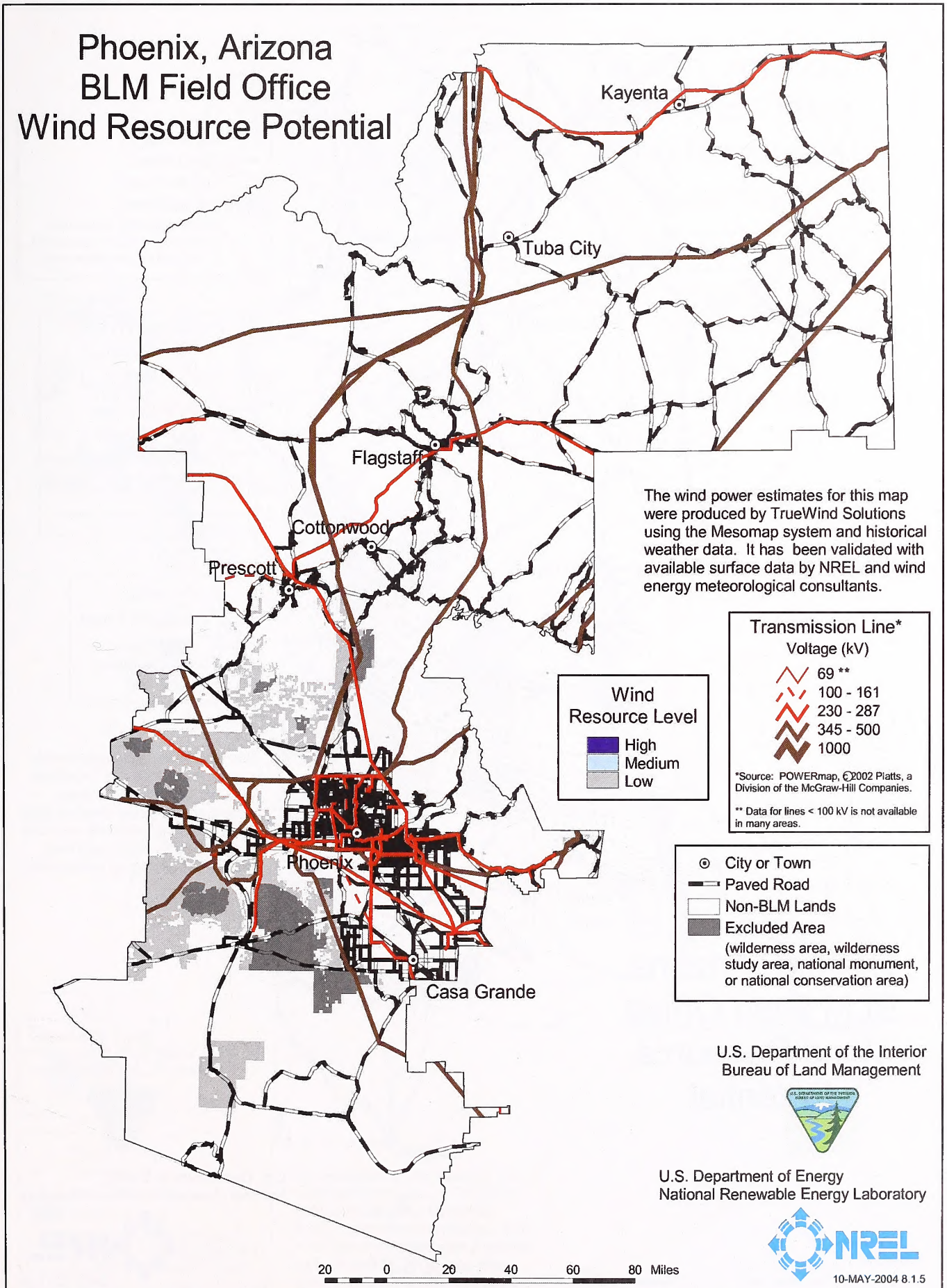


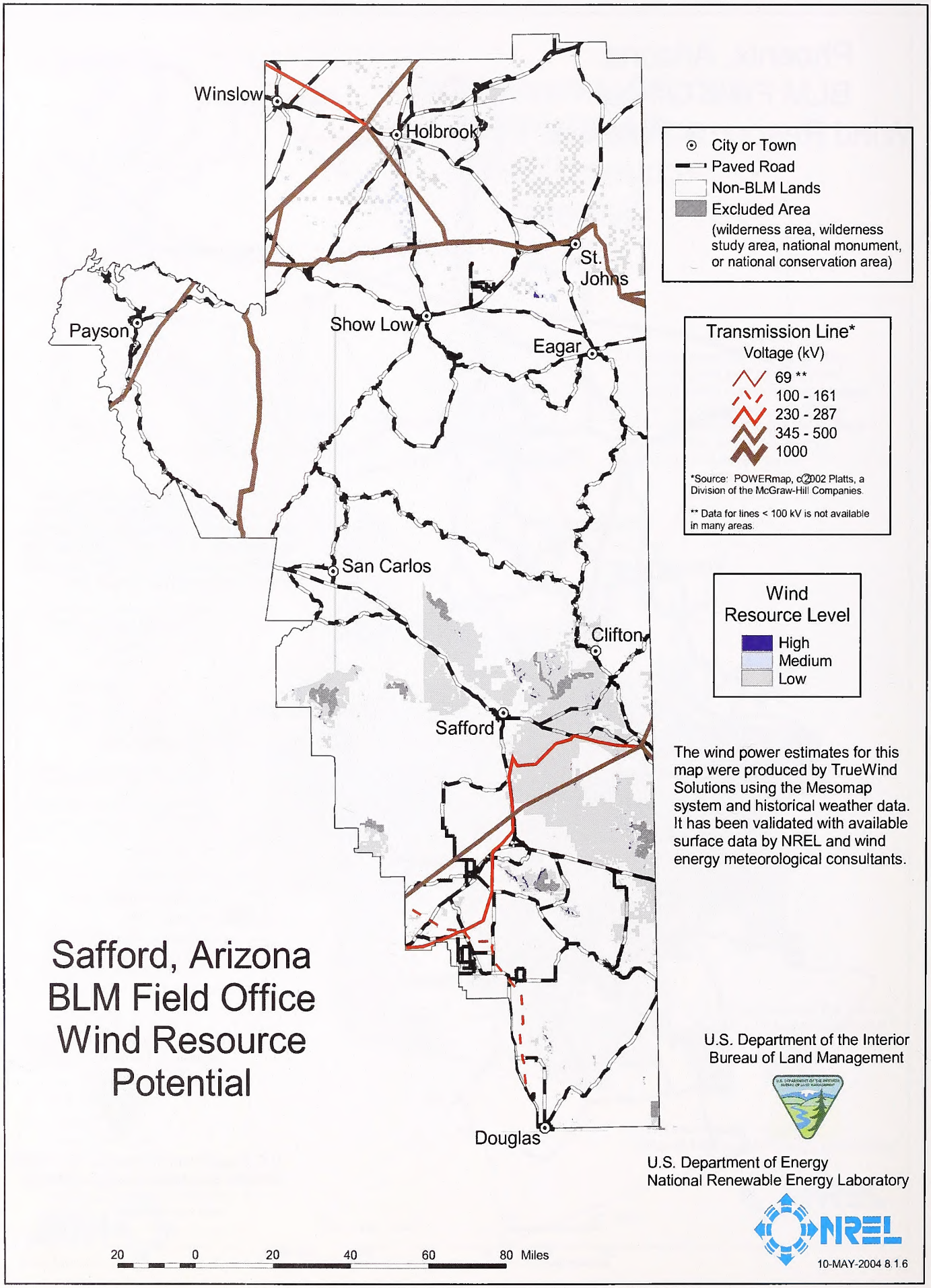
FIGURE B-3 Index Map Showing Locations of Field Office Boundaries in Arizona

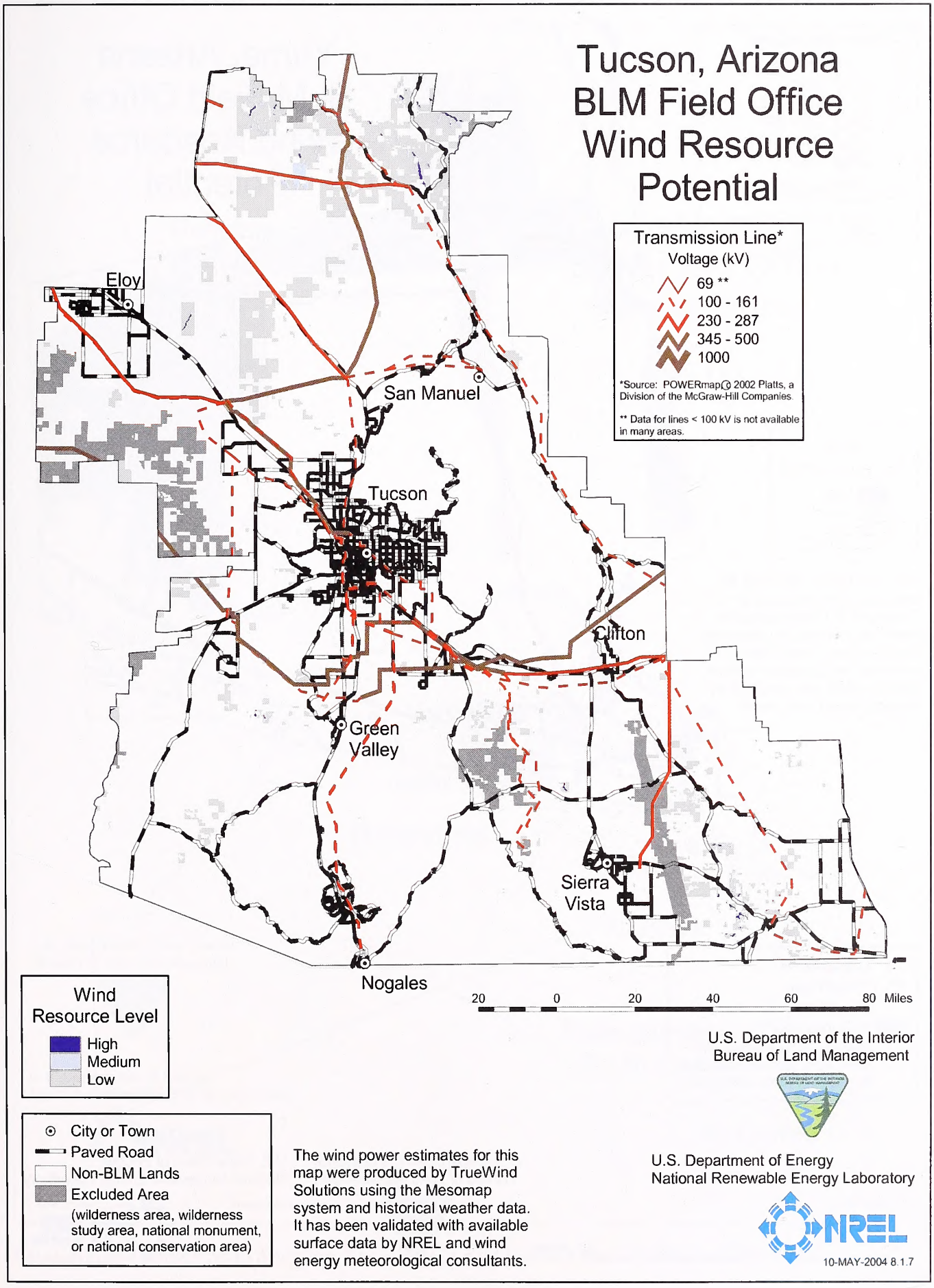

Littlefield
Colorado City
Fredonia
Page
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Arizona Strip, Arizona
BLM Field Office
Wind Resource
Potential
10 0 10 20 Miles
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind Resource Level
High
Medium
Low
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
14-MAR-2004 8.1.1


Kingman, Arizona
BLM Field Office
Wind Resource
Potential
Peach
Springs
Kingman
Yucca
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind
Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap© 2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
10 0 10 20 Miles
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
14-MAR-2004 8.1.2


Lake Havasu, Arizona
BLM Field Office
Wind Resource
Potential
Bullhead City
Needles
Lake Havasu City
Parker
Salome
Wind Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap© 2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
10 0 10 20 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
14-MAR-2004 8.1.3


Phoenix, Arizona
BLM Field Office
Wind Resource Potential
Kayenta
Tuba City
Flagstaff
Cottonwood
Prescott
Phoenix
Casa Grande
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
20 0 20 40 60 80 Miles
10-MAY-2004 8.1.5


Winslow
Holbrook
St. Johns
Payson
Show Low
Eagar
San Carlos
Clifton
Safford
Douglas
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, c2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
Wind Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Safford, Arizona
BLM Field Office
Wind Resource
Potential
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
20 0 20 40 60 80 Miles
10-MAY-2004 8.1.6


Tucson, Arizona
BLM Field Office
Wind Resource
Potential
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap© 2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
Eloy
San Manuel
Tucson
Clifton
Green Valley
Sierra Vista
Nogales
20 0 20 40 60 80 Miles
Wind Resource Level
High
Medium
Low
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
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NREL
10-MAY-2004 8.1.7

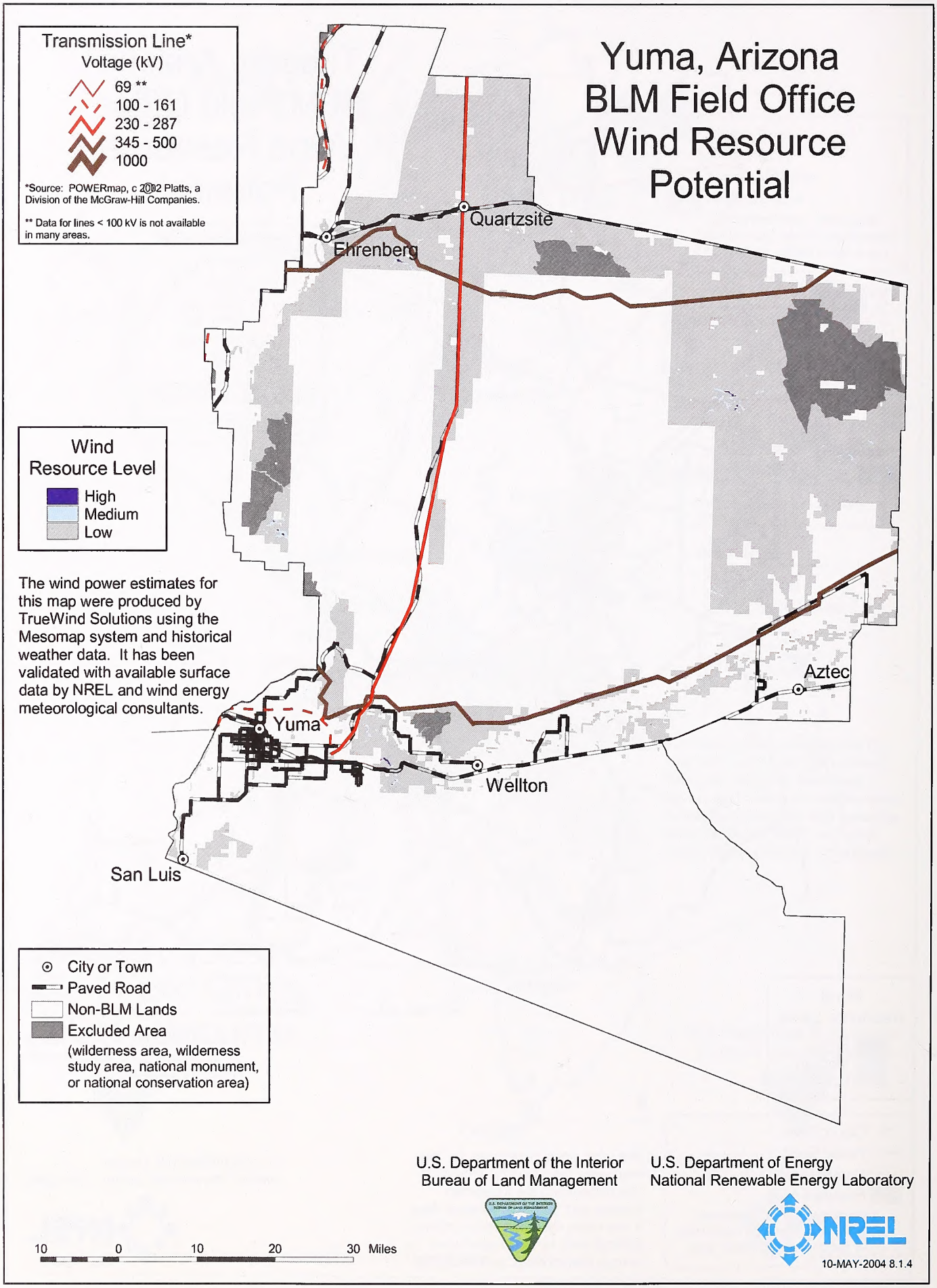
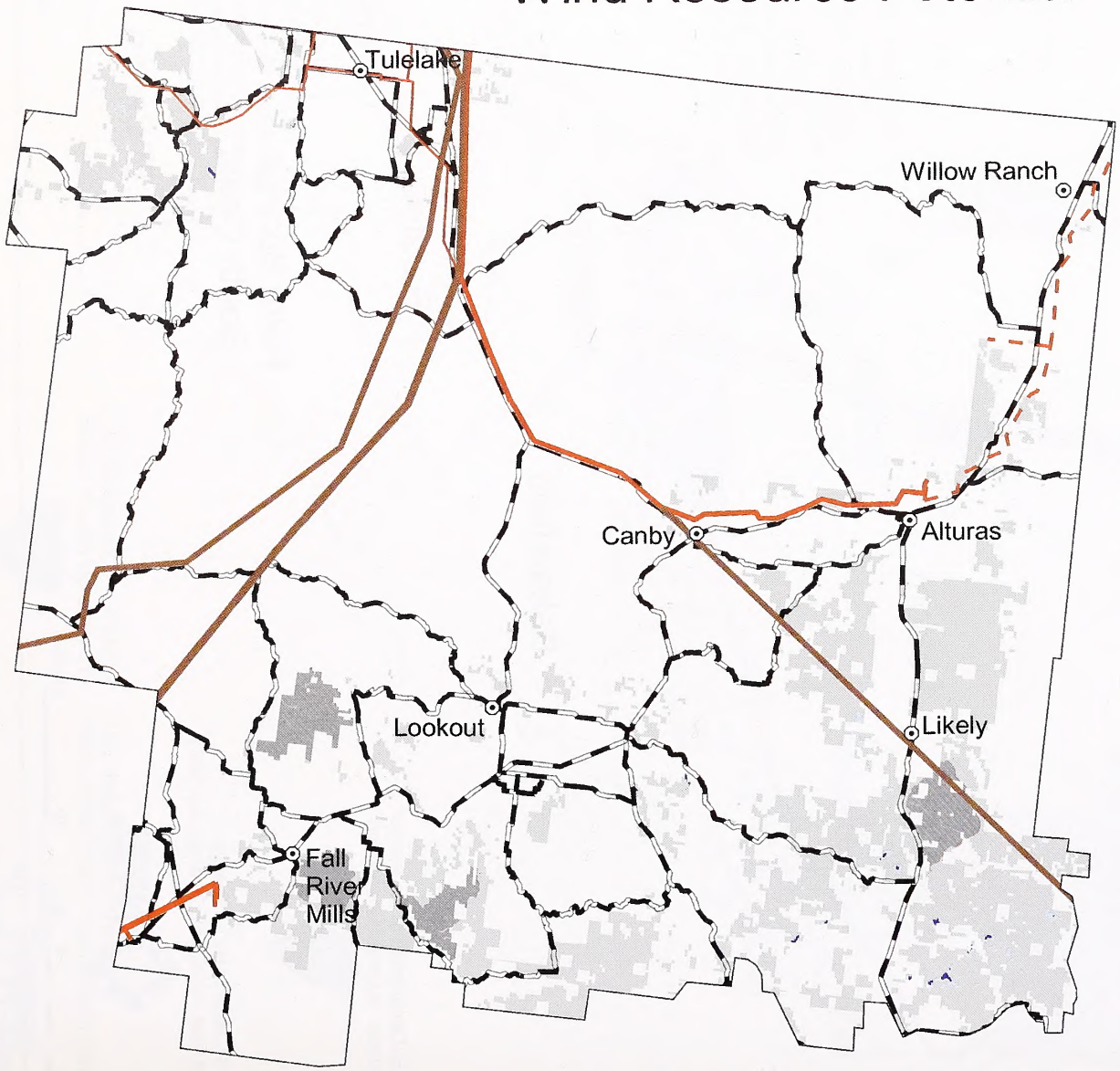

Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, c 2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
Yuma, Arizona
BLM Field Office
Wind Resource
Potential
Quartzsite
Ehrenberg
Wind
Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Aztec
Yuma
Wellton
San Luis
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
10 0 10 20 30 Miles
10-MAY-2004 8.1.4



FIGURE B-4 Index Map Showing Locations of Field Office Boundaries in California

Alturas, California BLM Field Office
Wind Resource Potential



Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000

*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.

** Data for lines < 100 kV is not available in many areas.

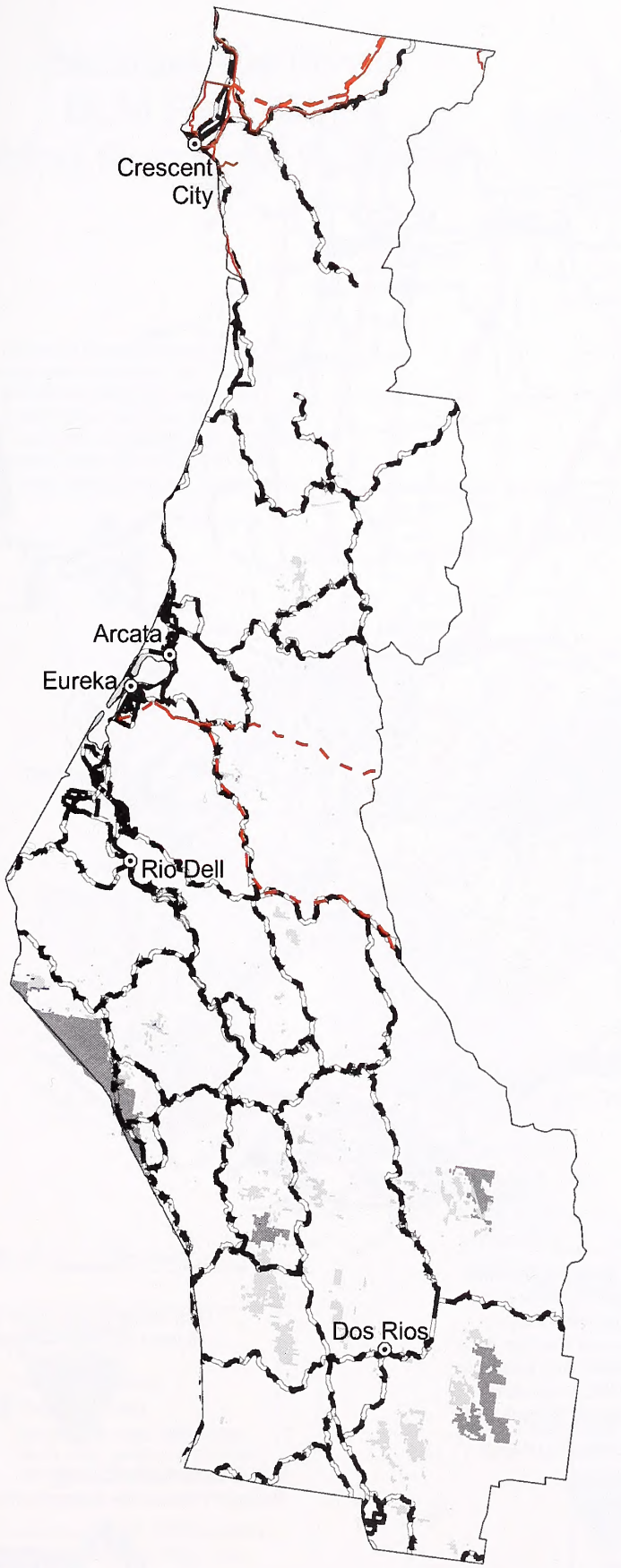
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

Wind Resource Level
High
Medium
Low

City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)

U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory
NREL
10-MAY-2004 10.1.3



Arcata, California BLM Field Office Wind Resource Potential

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

Wind Resource Level

- High
- Medium
- Low

Transmission Line*

Voltage (kV)

- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.

** Data for lines < 100 kV is not available in many areas.

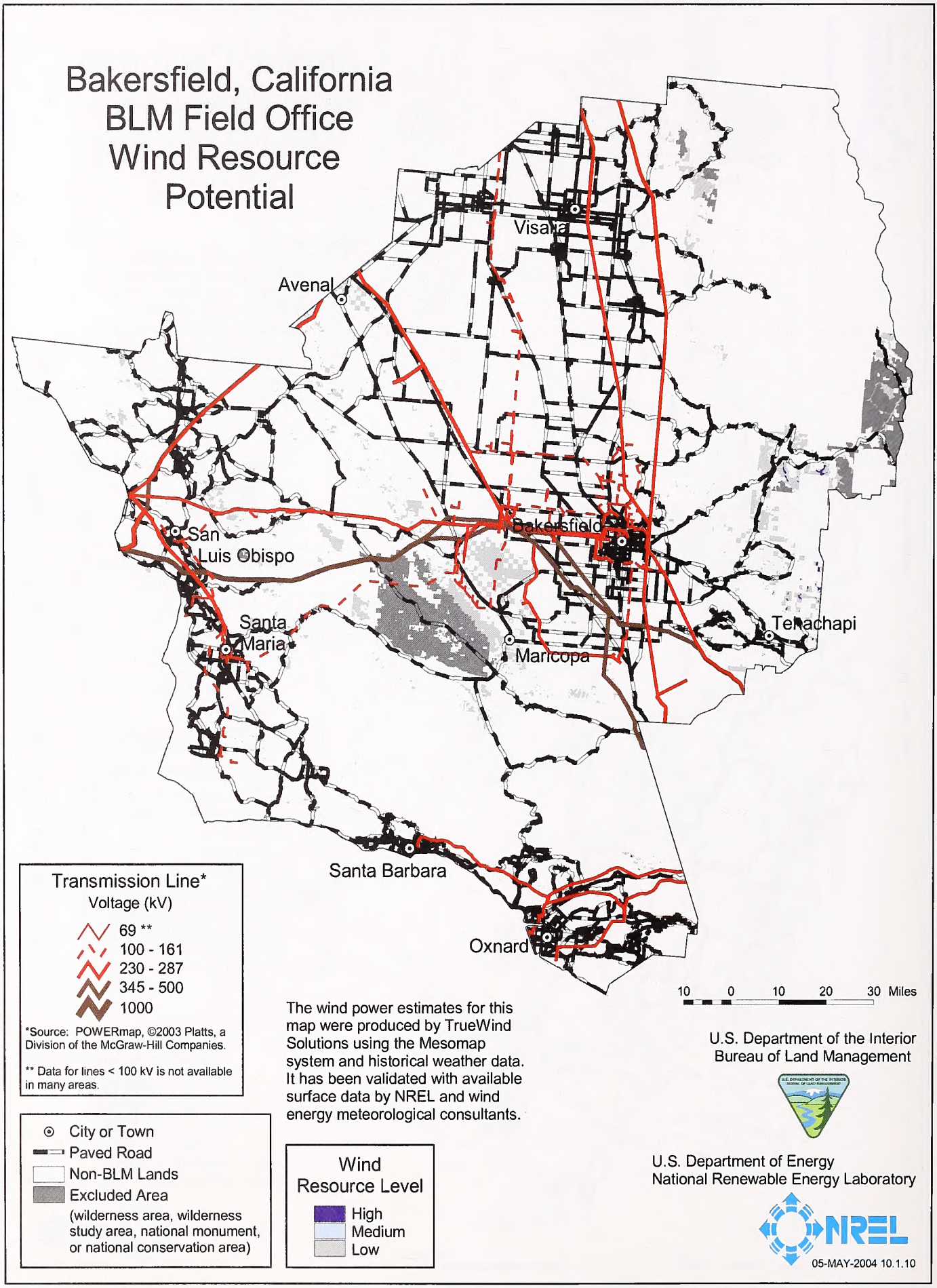
- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

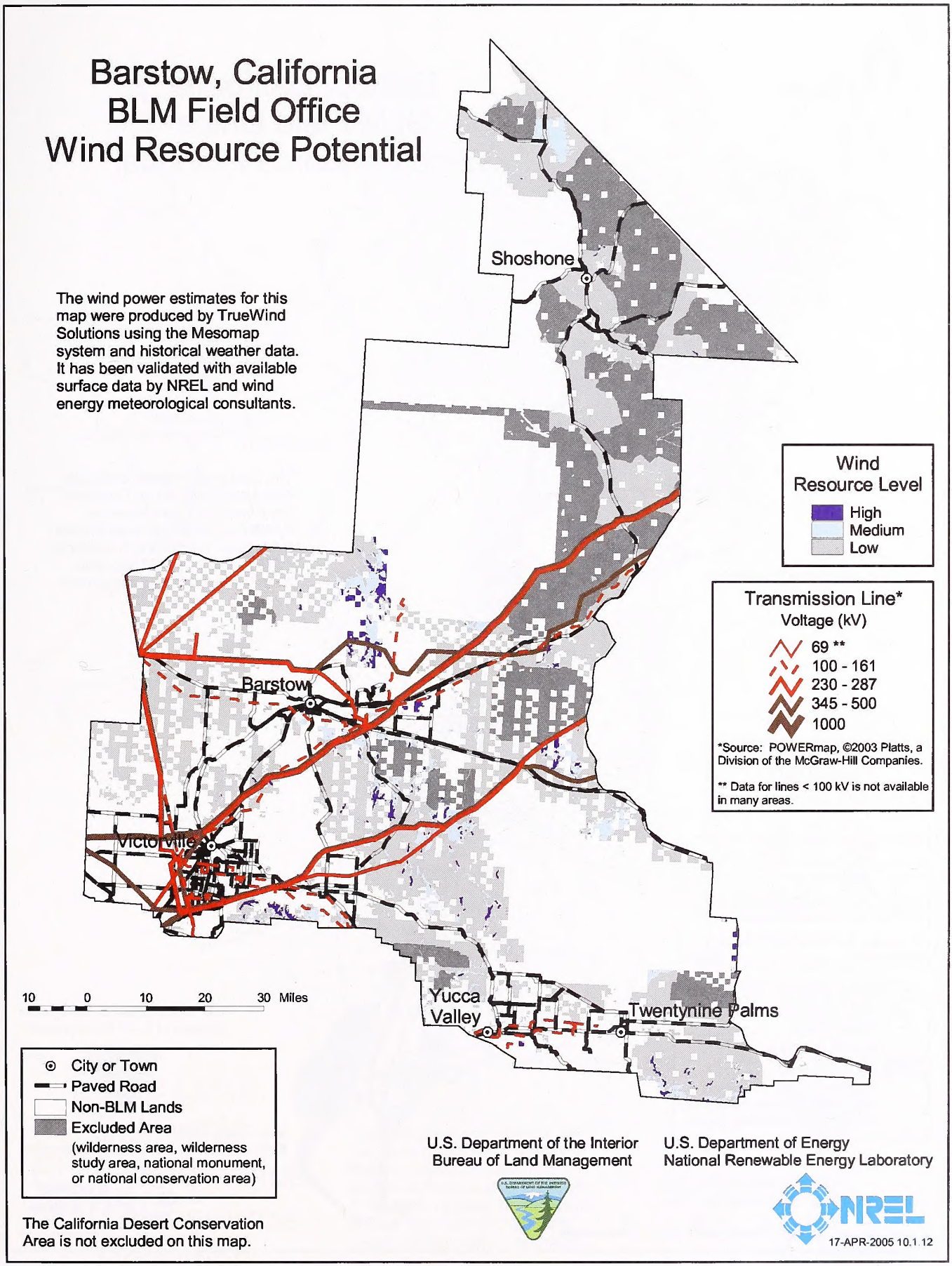
U.S. Department of the Interior
Bureau of Land Management

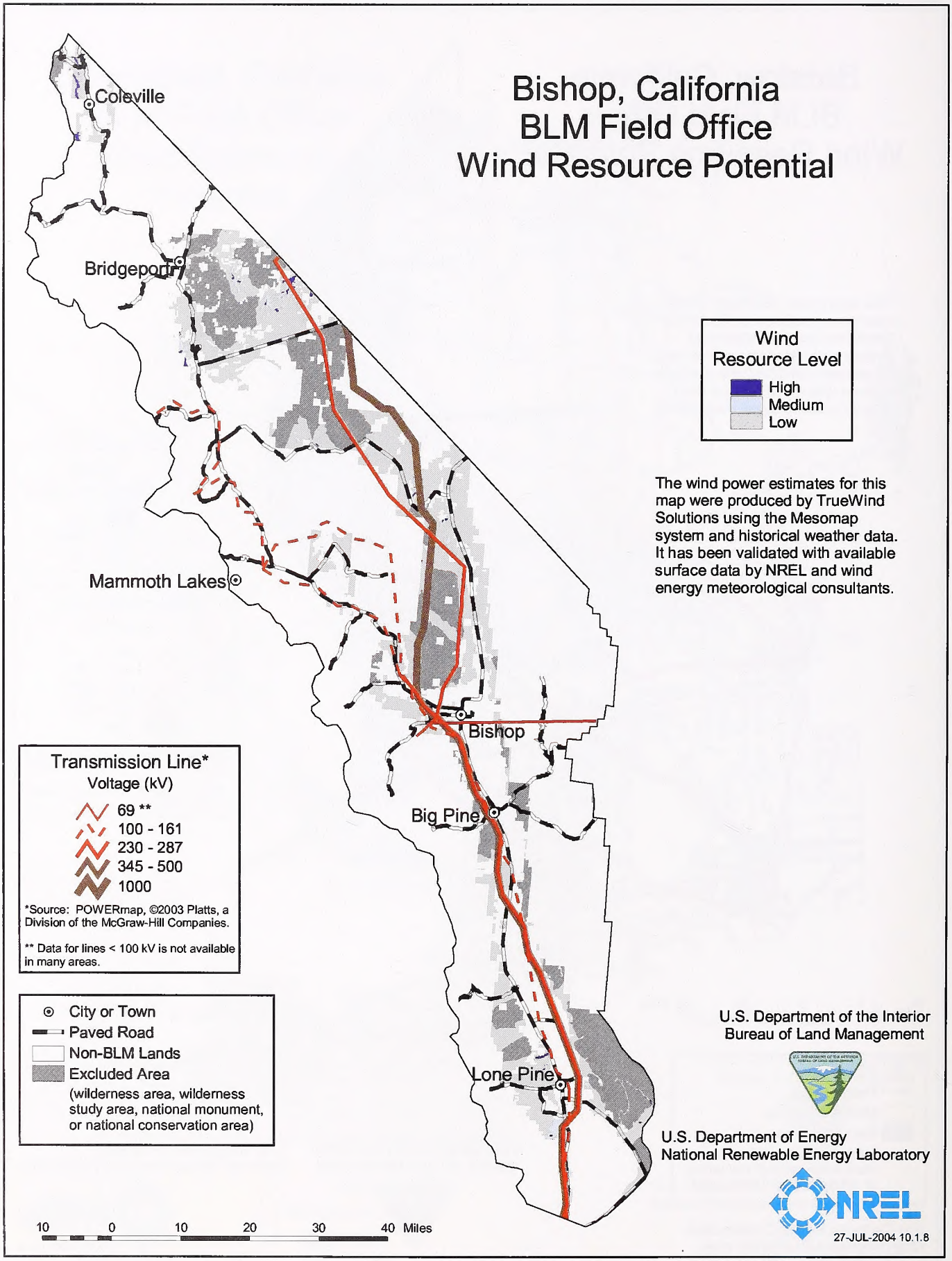
U.S. Department of Energy
National Renewable Energy Laboratory

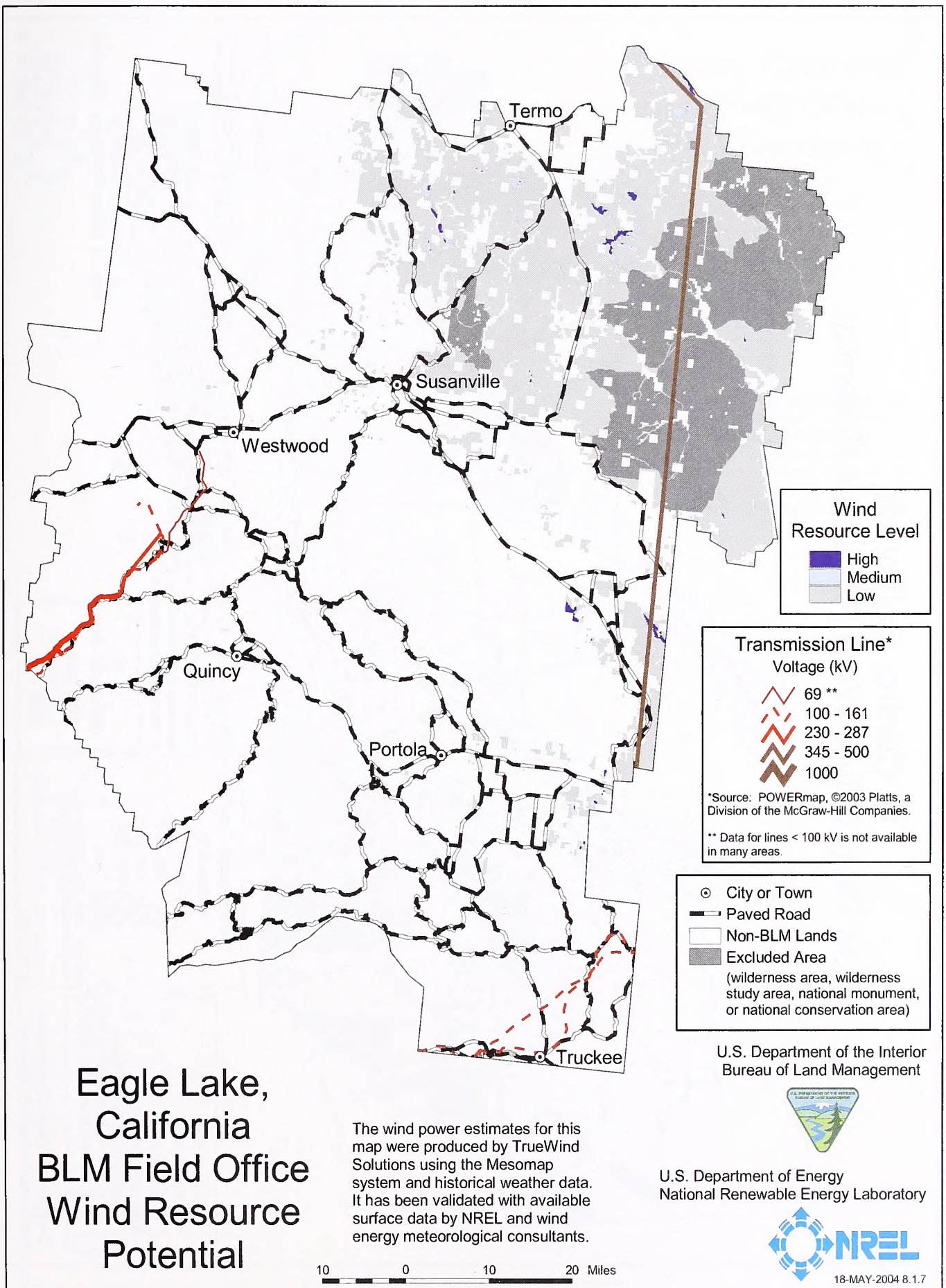
NREL

17-MAY-2004 10.1.1

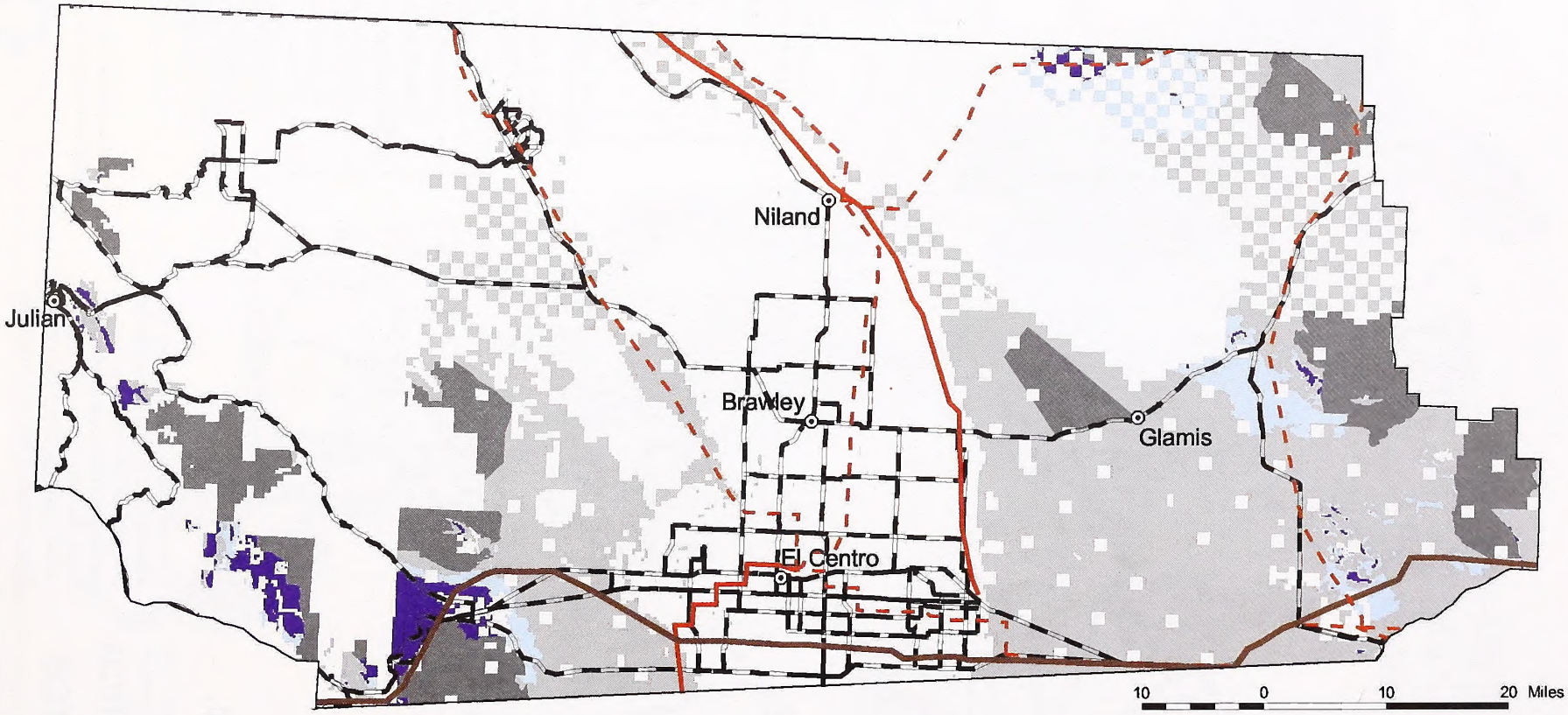

Bakersfield, California
BLM Field Office
Wind Resource
Potential
Visalia
Avenal
San
Luis Obispo
Bakersfield
Santa
Maria
Maricopa
Tehachapi
Santa Barbara
Oxnard
10 0 10 20 30 Miles
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind
Resource Level
High
Medium
Low
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
05-MAY-2004 10.1.10


Barstow, California
BLM Field Office
Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Shoshone
Barstow
Victorville
Yucca Valley
Twentynine Palms
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
10 0 10 20 30 Miles
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
The California Desert Conservation Area is not excluded on this map.
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
17-APR-2005 10.1.12


Bishop, California
BLM Field Office
Wind Resource Potential
Coleville
Bridgeport
Mammoth Lakes
Bishop
Big Pine
Lone Pine
Wind Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
10 0 10 20 30 40 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
27-JUL-2004 10.1.8


Termo
Susanville
Westwood
Quincy
Portola
Truckee
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
18-MAY-2004 8.1.7
Eagle Lake, California BLM Field Office Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
10 0 10 20 Miles

El Centro, California
BLM Field Office Wind Resource Potential



City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)

The California Desert Conservation Area is not excluded on this map.

Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000

*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.

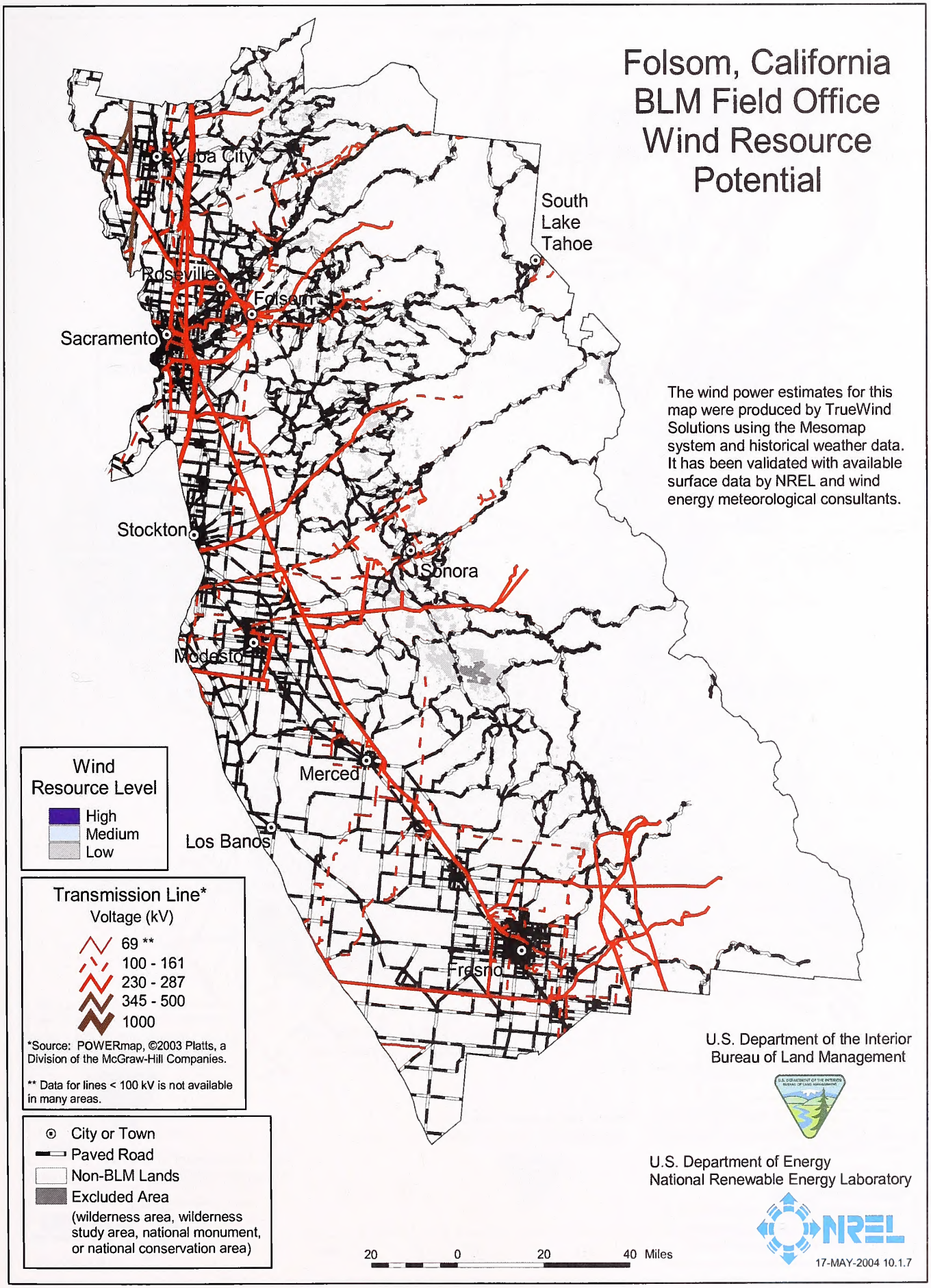
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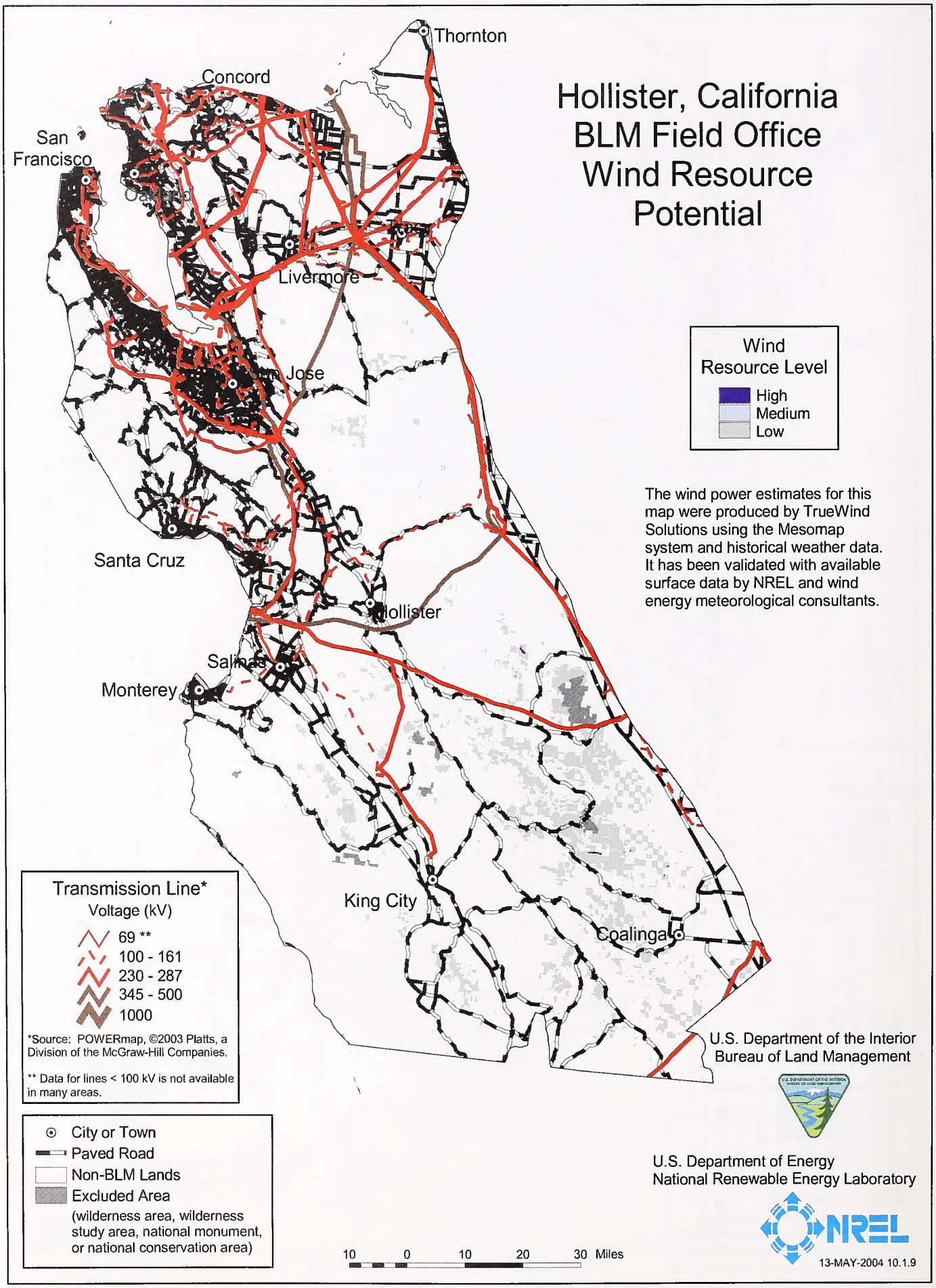
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

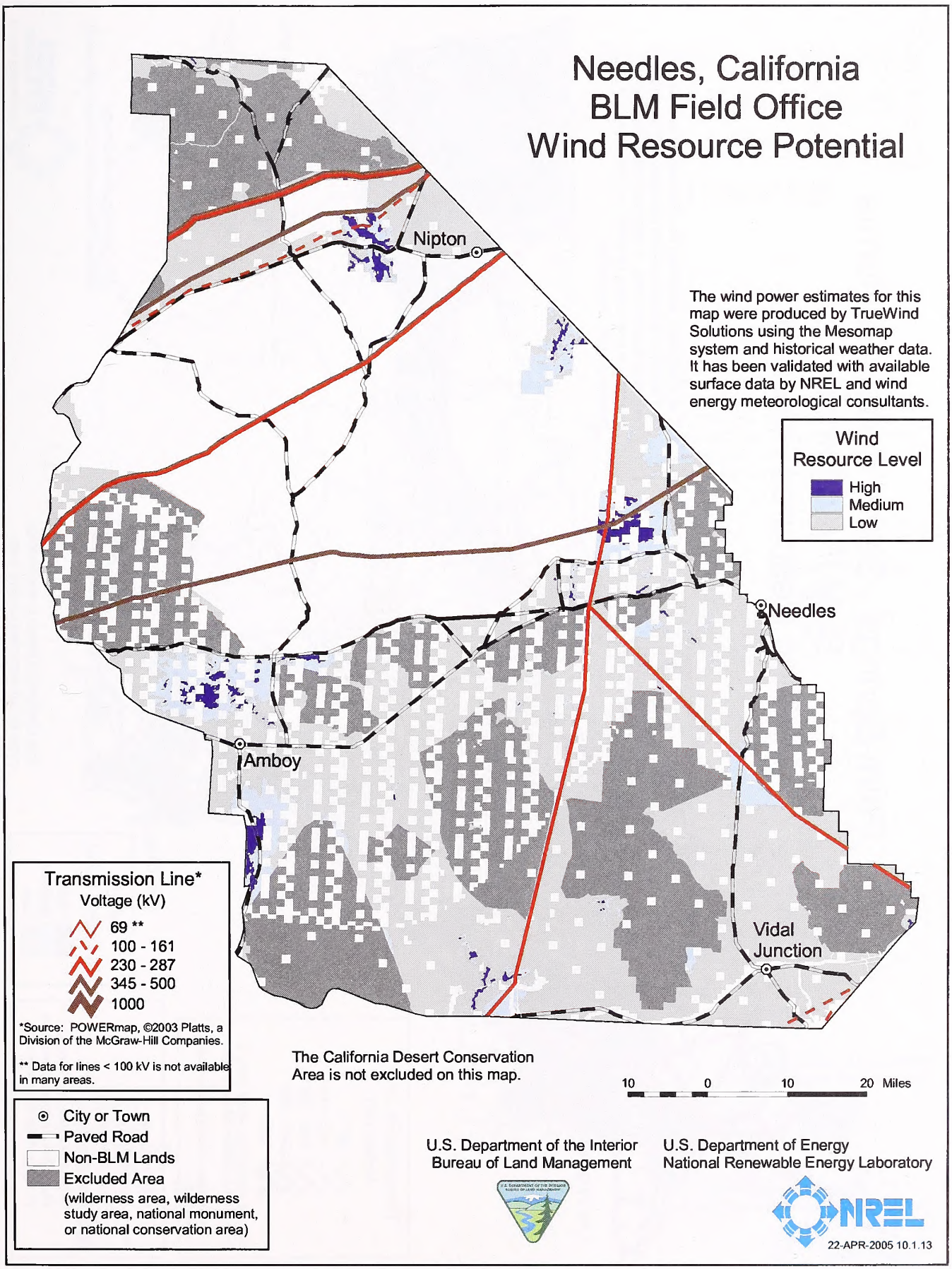
Wind Resource Level
High
Medium
Low

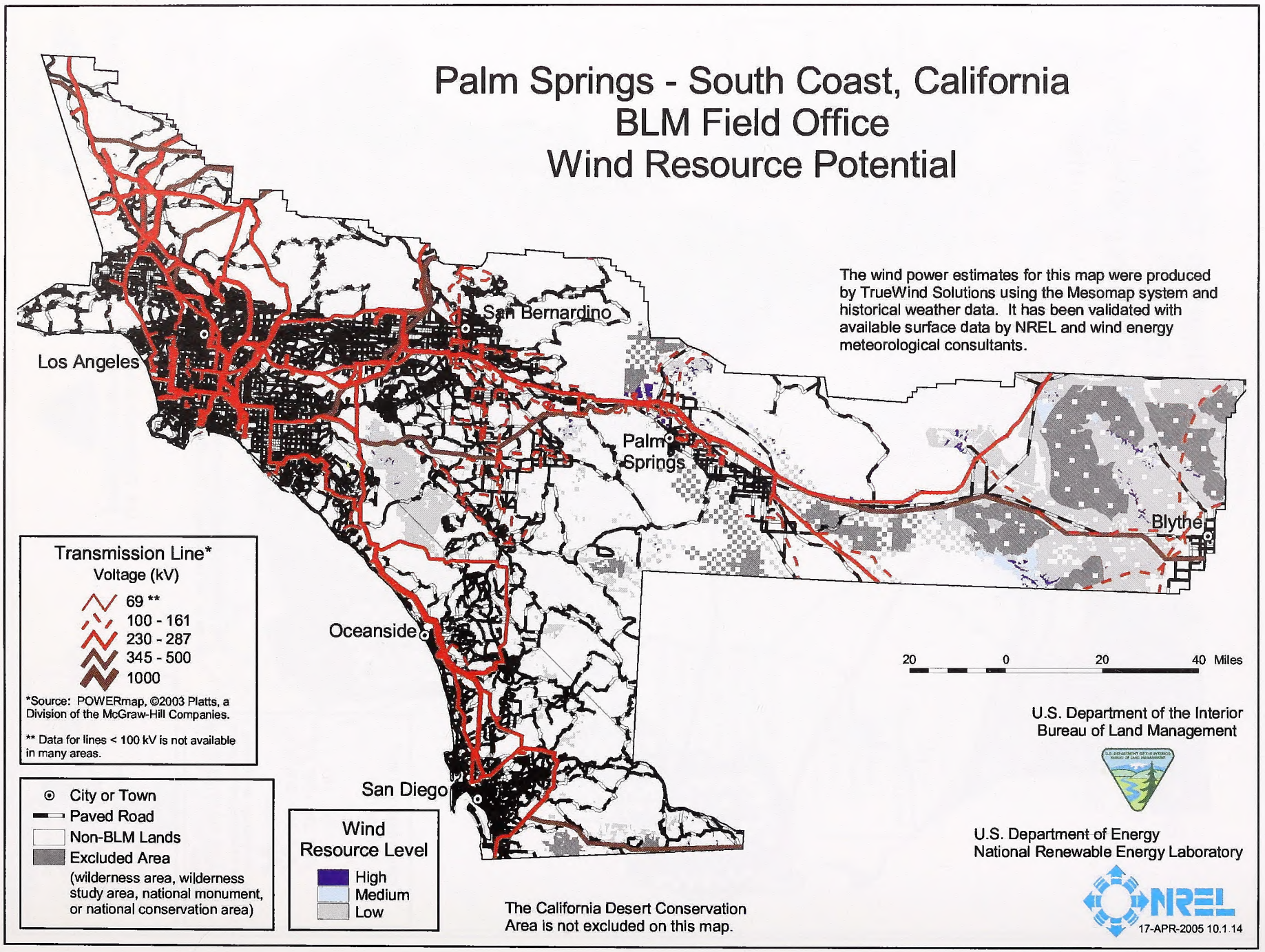
U.S. Department of the Interior
Bureau of Land Management

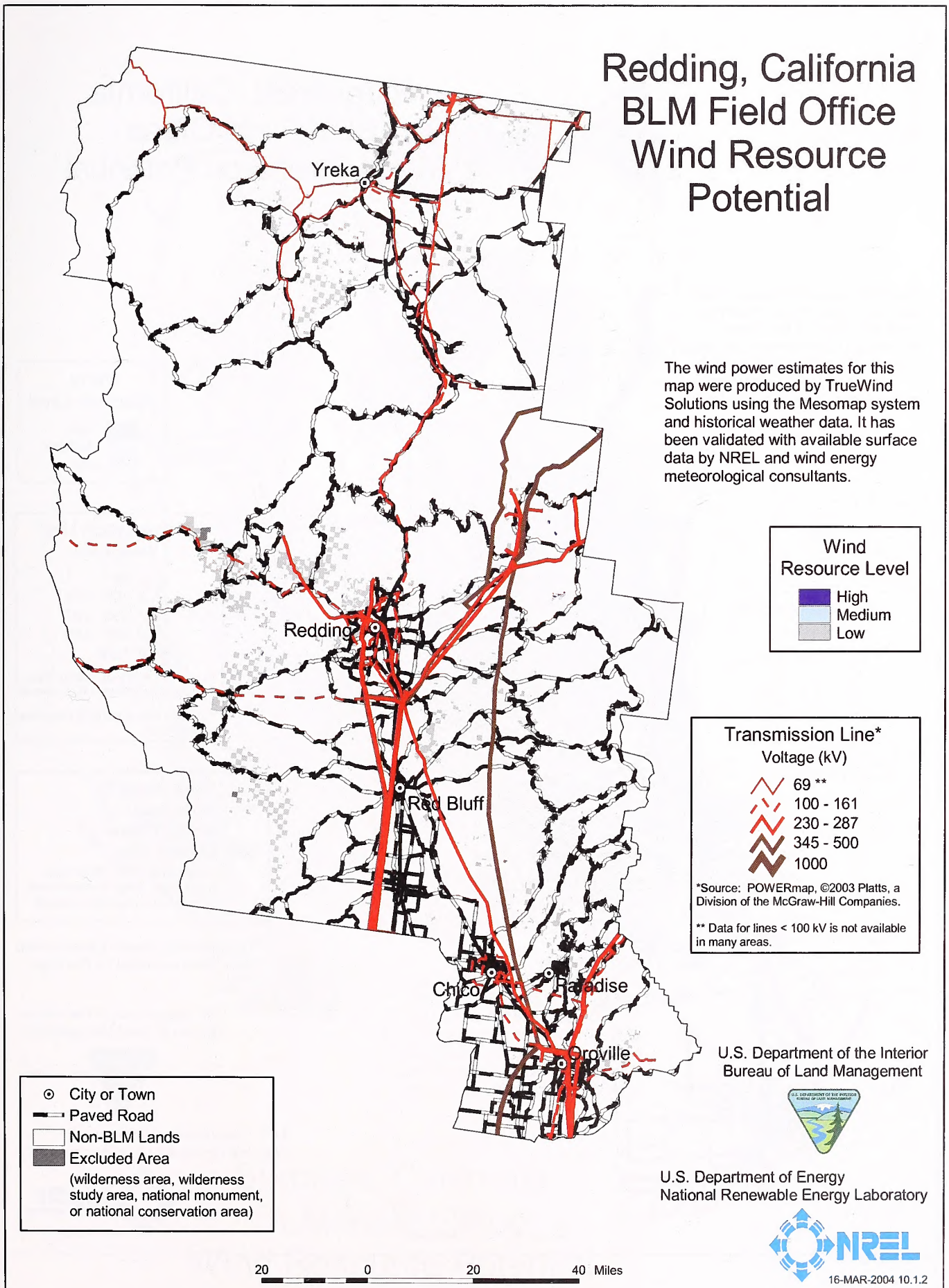
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
17-APR-2005 10:1,15

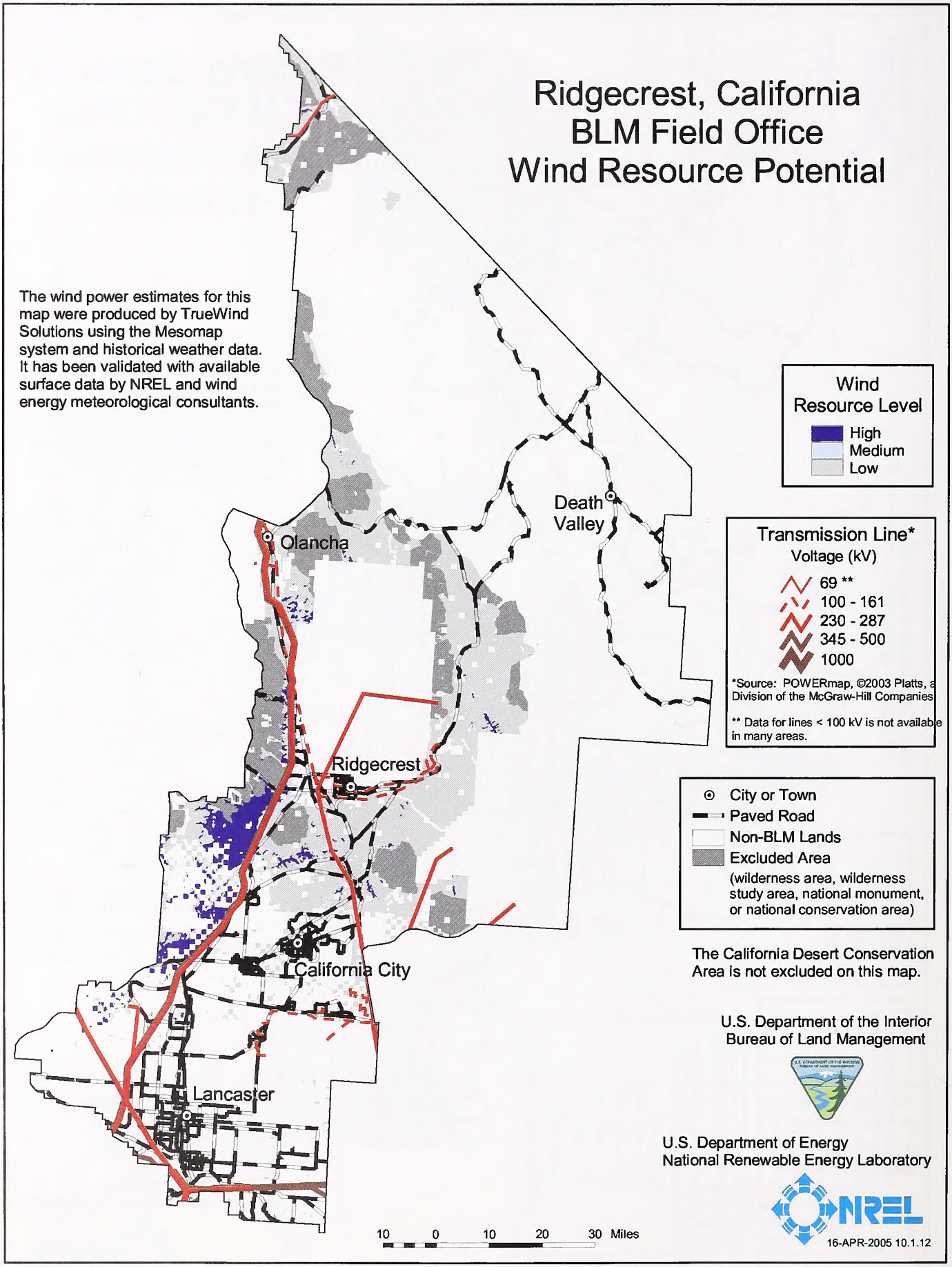

Folsom, California
BLM Field Office
Wind Resource
Potential
Yuba City
South
Lake
Tahoe
Roseville
Folsom
Sacramento
Stockton
Sonora
Modesto
Merced
Los Banos
Fresno
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind
Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
20 0 20 40 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
17-MAY-2004 10.1.7

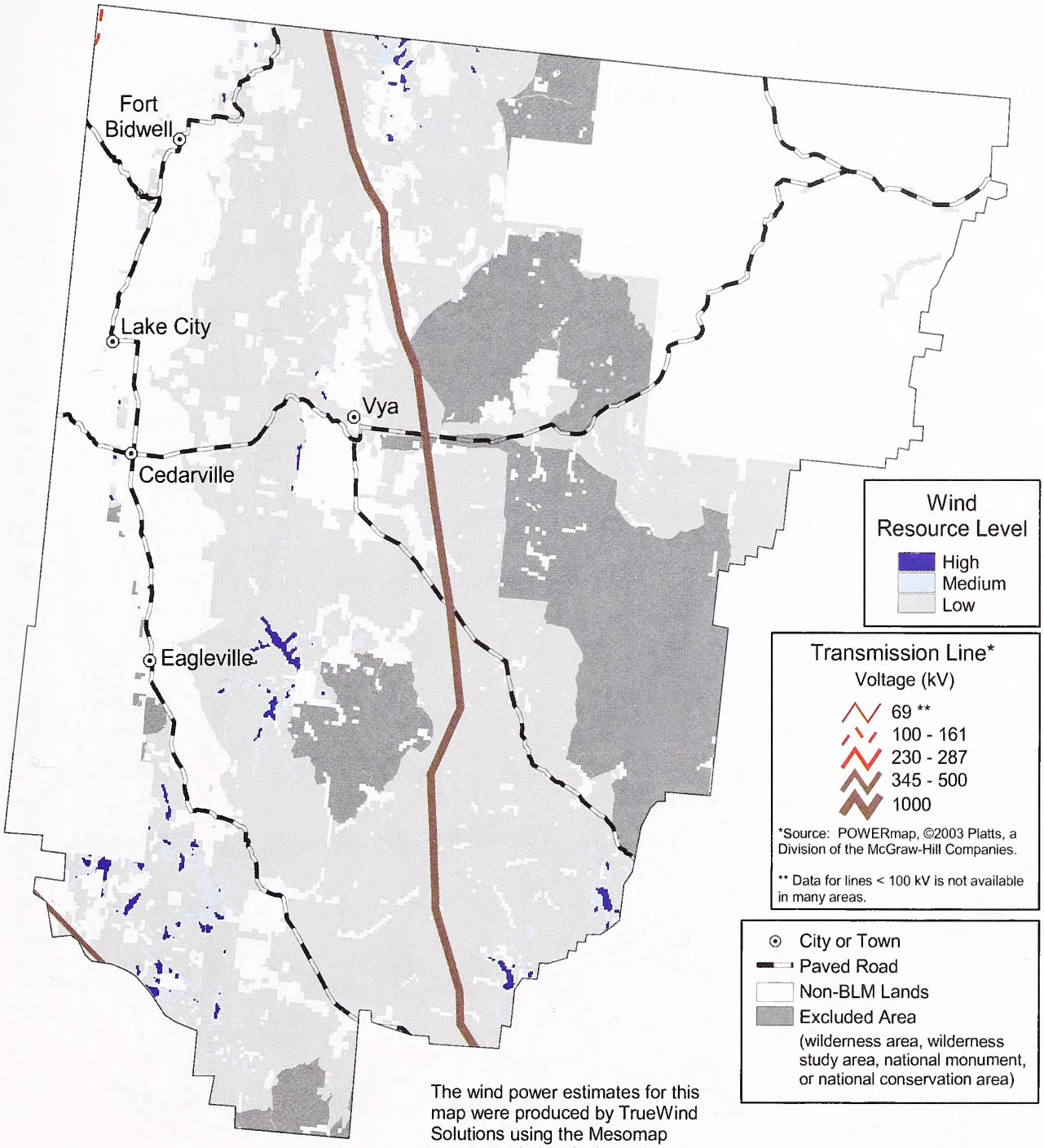

Hollister, California
BLM Field Office
Wind Resource
Potential
Thornton
Concord
San Francisco
Livermore
San Jose
Santa Cruz
Hollister
Salinas
Monterey
King City
Coalinga
Wind Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
10 0 10 20 30 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
13-MAY-2004 10.1.9


Needles, California
BLM Field Office
Wind Resource Potential
Nipton
Needles
Amboy
Vidal Junction
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
The California Desert Conservation Area is not excluded on this map.
10 0 10 20 Miles
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
22-APR-2005 10.1.13


Palm Springs - South Coast, California
BLM Field Office
Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Los Angeles
San Bernardino
Palm Springs
Blythe
Oceanside
San Diego
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind Resource Level
High
Medium
Low
The California Desert Conservation Area is not excluded on this map.
20 0 20 40 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
17-APR-2005 10.1.14


Redding, California
BLM Field Office
Wind Resource
Potential
Yreka
Redding
Red Bluff
Chico
Paradise
Oroville
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
20 0 20 40 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
16-MAR-2004 10.1.2


Ridgecrest, California
BLM Field Office
Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
The California Desert Conservation Area is not excluded on this map.
Olancha
Death Valley
Ridgecrest
California City
Lancaster
10 0 10 20 30 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
16-APR-2005 10.1.12



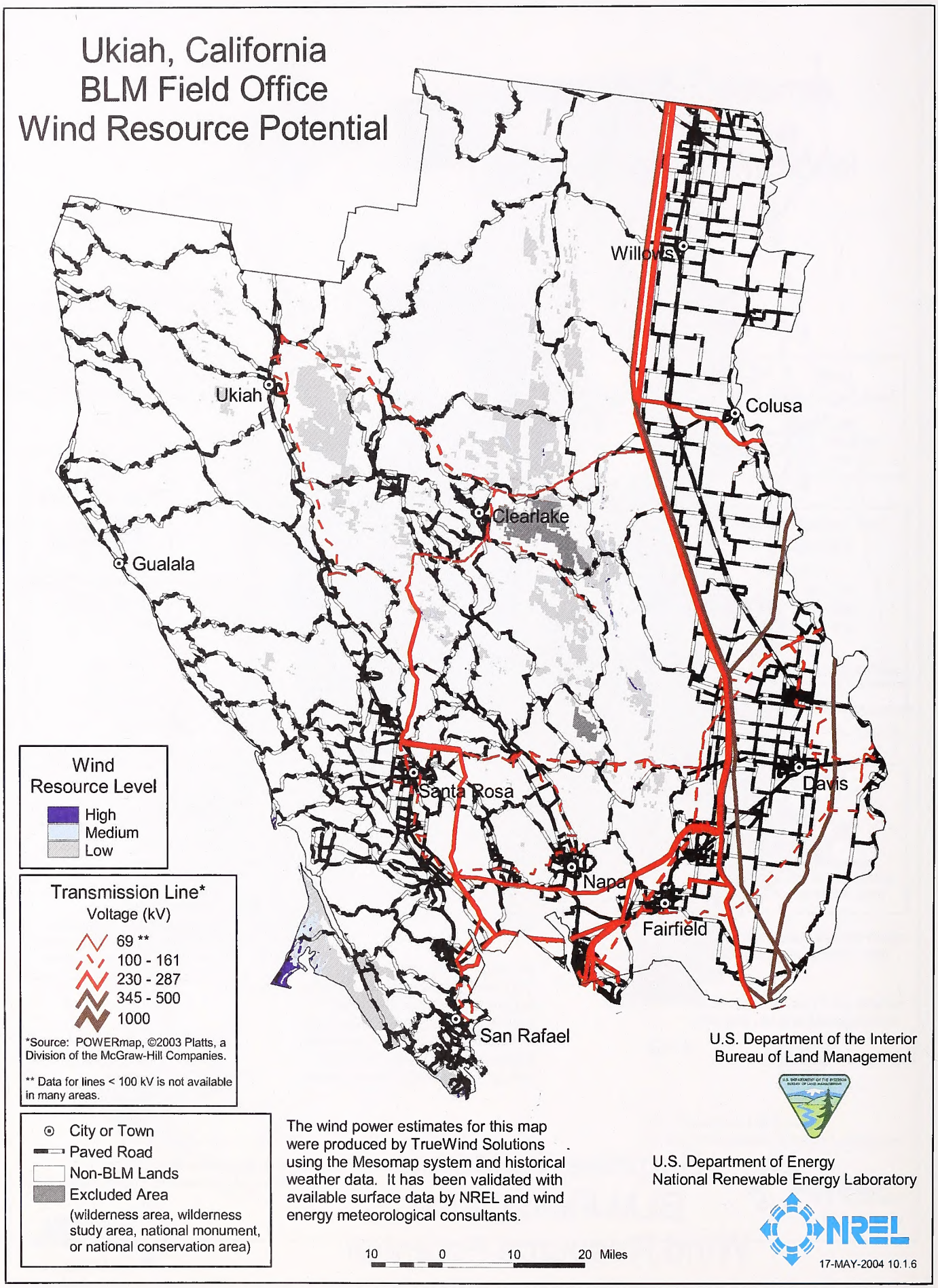
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory

Surprise, California
BLM Field Office
Wind Resource Potential

17-MAY-2004 10.1.4


Ukiah, California
BLM Field Office
Wind Resource Potential
Willows
Ukiah
Colusa
Clearlake
Gualala
Santa Rosa
Davis
Napa
Fairfield
San Rafael
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
10 0 10 20 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
17-MAY-2004 10.1.6

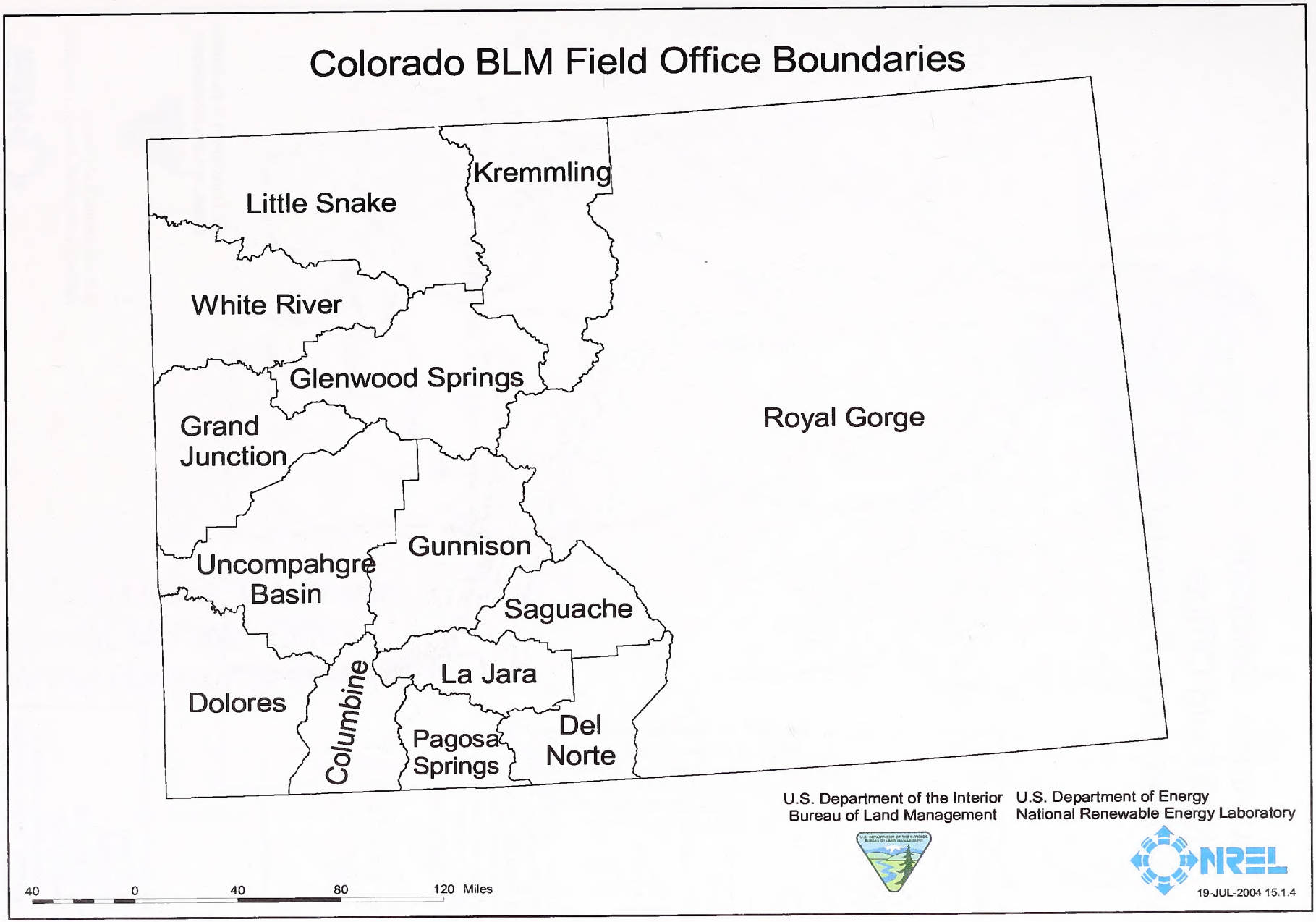
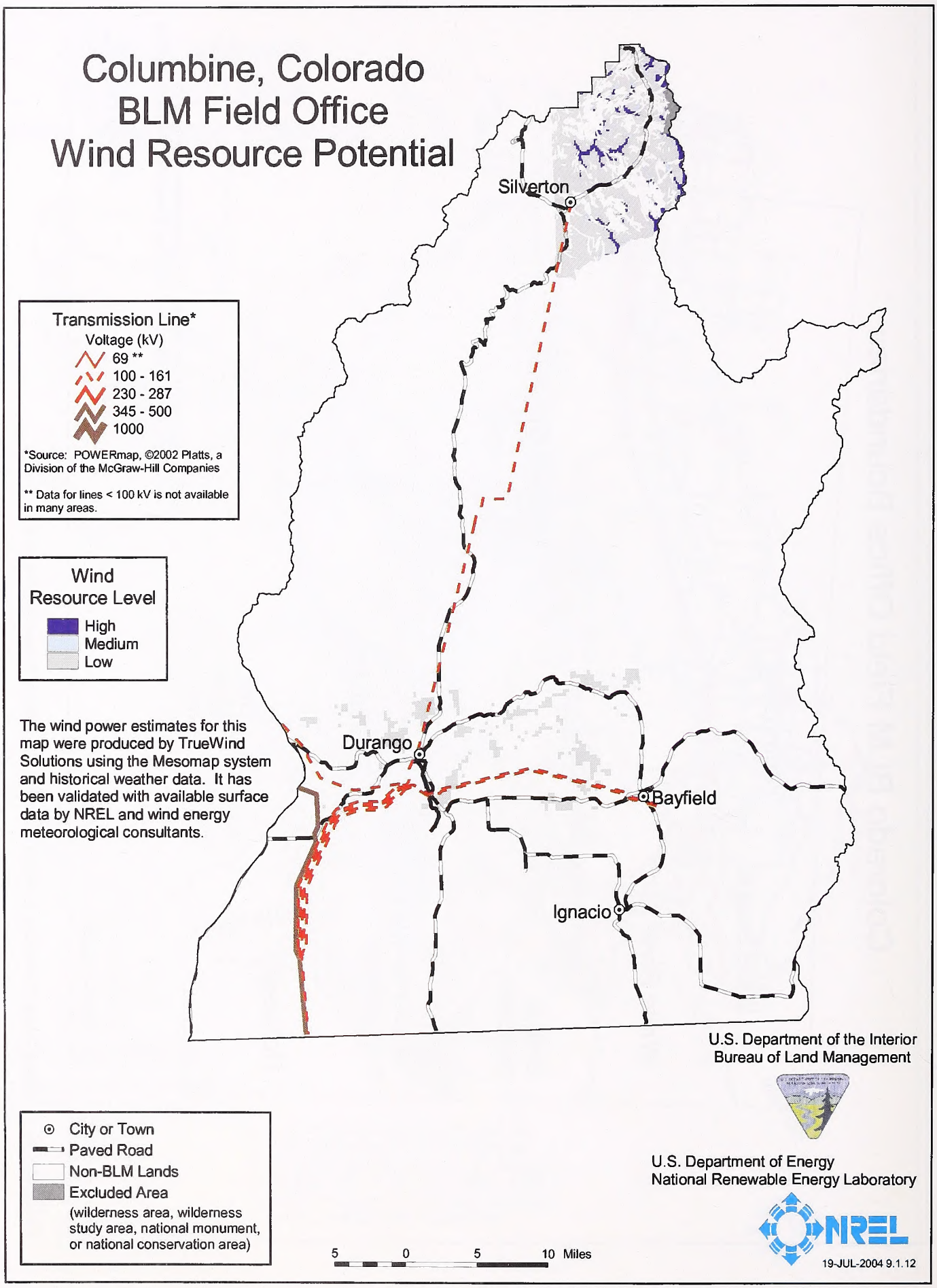
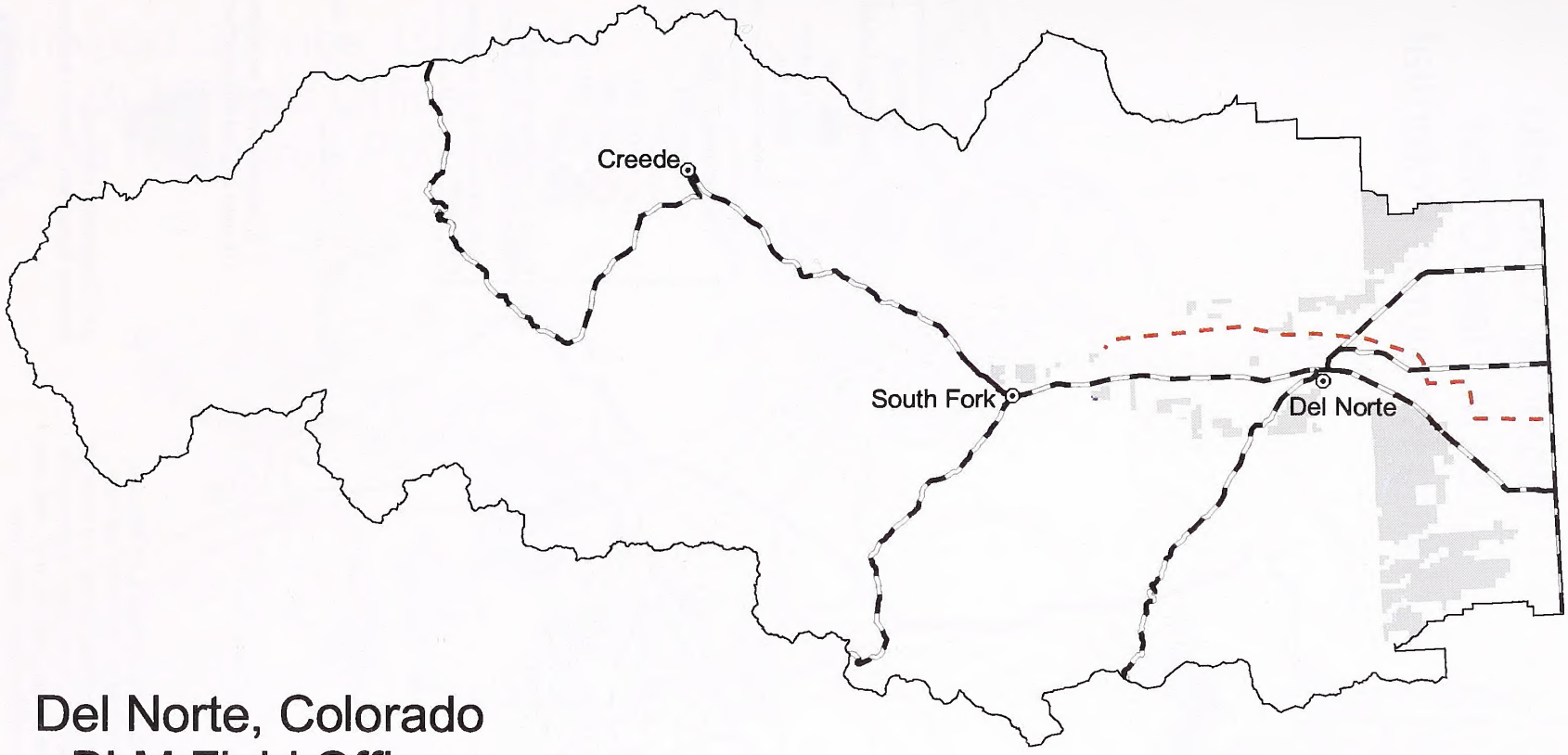


FIGURE B-5 Index Map Showing Locations of Field Office Boundaries in Colorado


Columbine, Colorado
BLM Field Office
Wind Resource Potential
Silverton
Durango
Bayfield
Ignacio
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
Wind Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
5 0 5 10 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
19-JUL-2004 9.1.12



Del Norte, Colorado
BLM Field Office
Wind Resource Potential

5 0 5 10 15 Miles

City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)

Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

** Data for lines < 100 kV is not available in many areas.

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

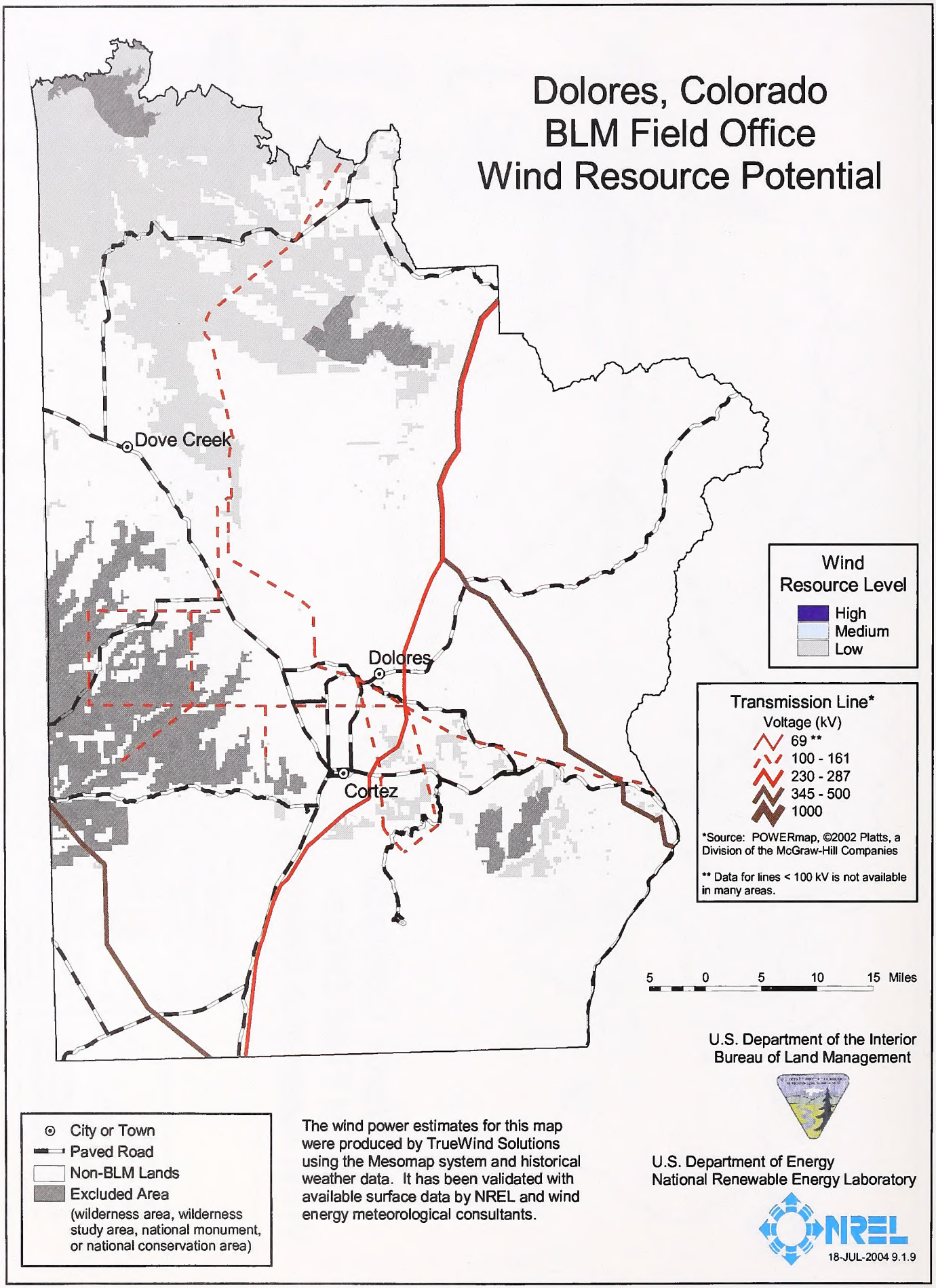
Wind Resource Level
High
Medium
Low

U.S. Department of the Interior
Bureau of Land Management

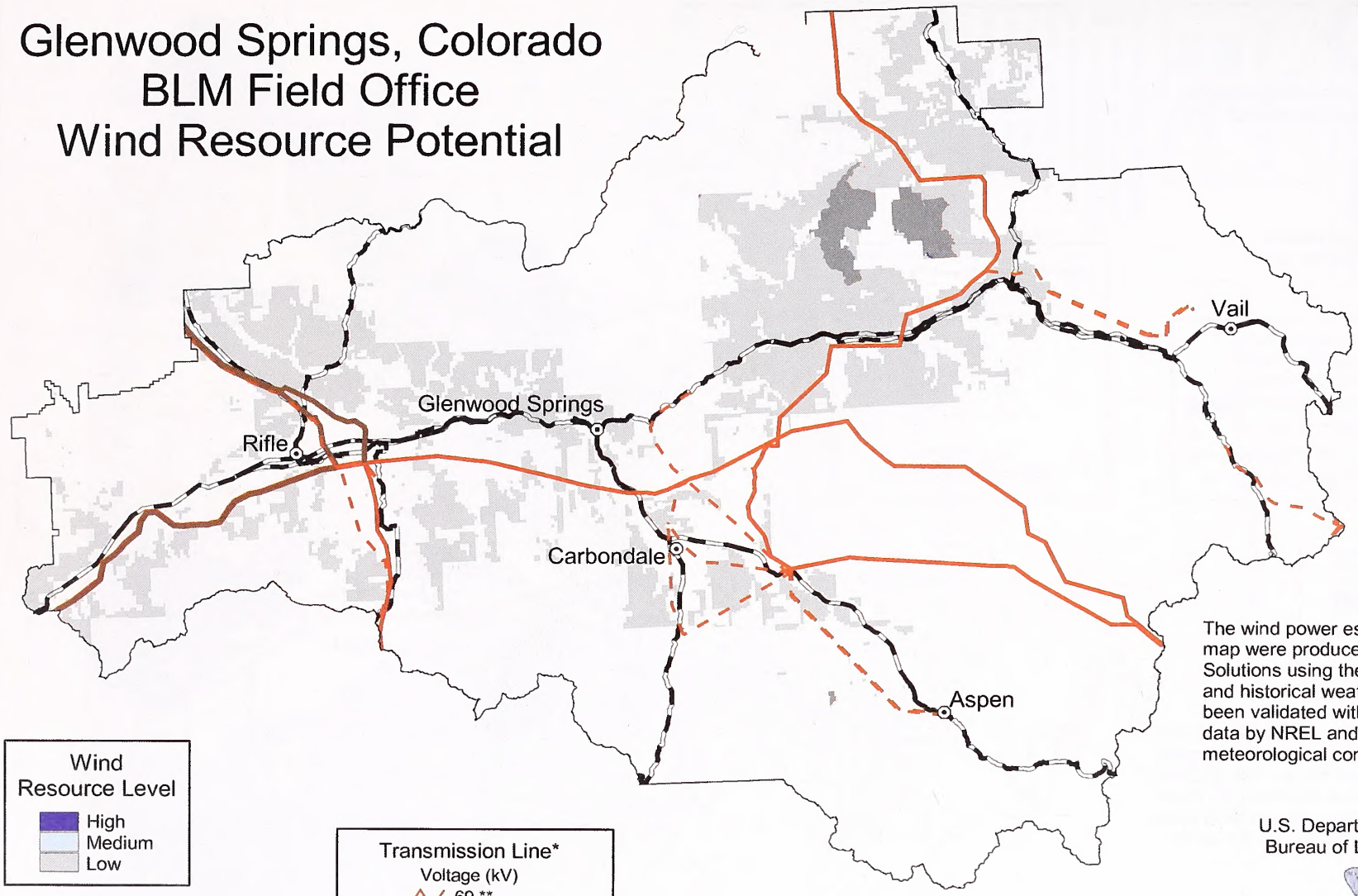
U.S. Department of Energy
National Renewable Energy Laboratory

NREL

18-JUL-2004 9.1.14


Dolores, Colorado
BLM Field Office
Wind Resource Potential
Dove Creek
Dolores
Cortez
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
5 0 5 10 15 Miles
U.S. Department of the Interior
Bureau of Land Management
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
18-JUL-2004 9.1.9

Glenwood Springs, Colorado
BLM Field Office
Wind Resource Potential



The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

Wind Resource Level
- High
- Medium
- Low

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

Transmission Line*
Voltage (kV)
- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

** Data for lines < 100 kV is not available in many areas.

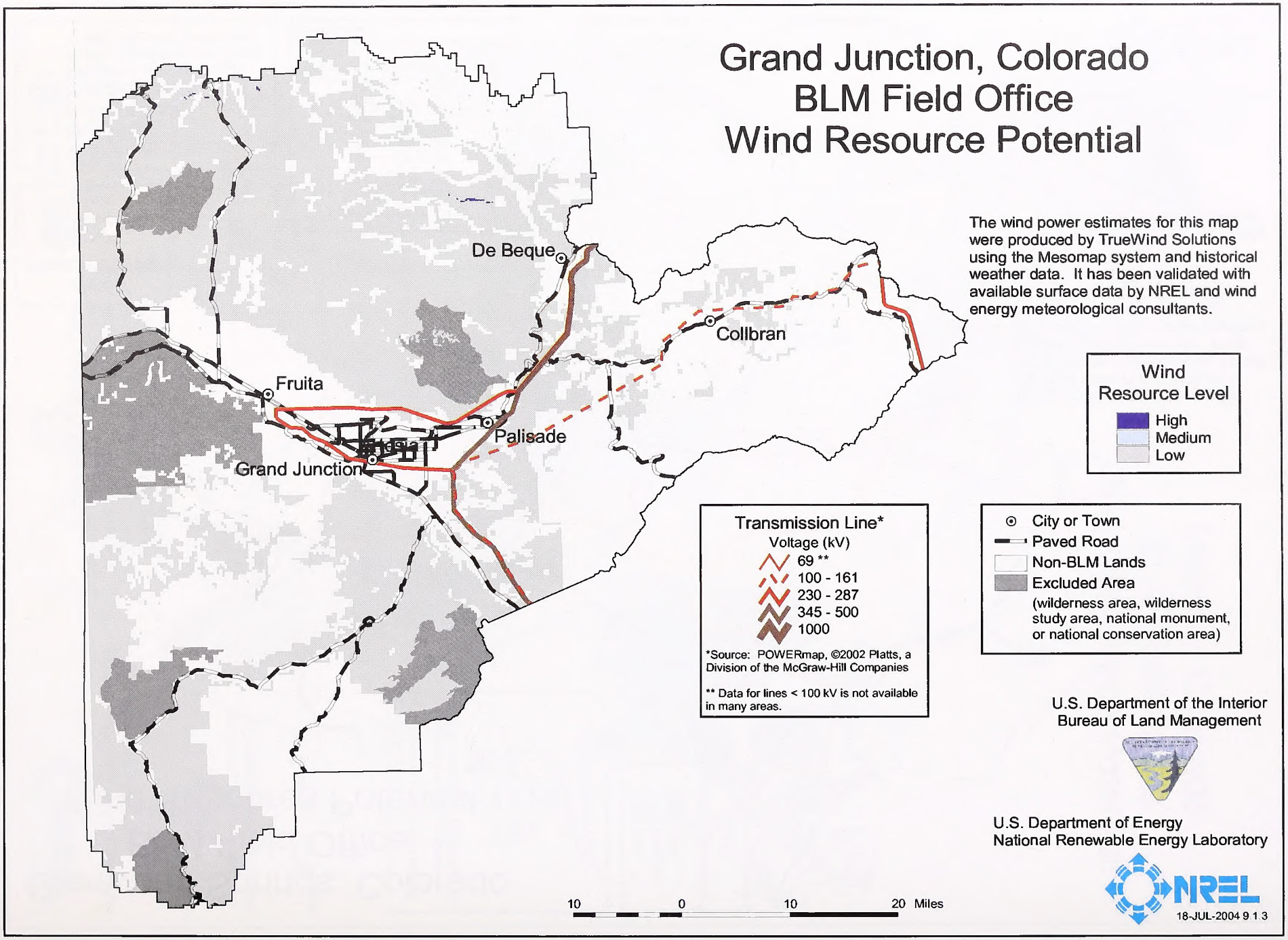
10 0 10 20 Miles

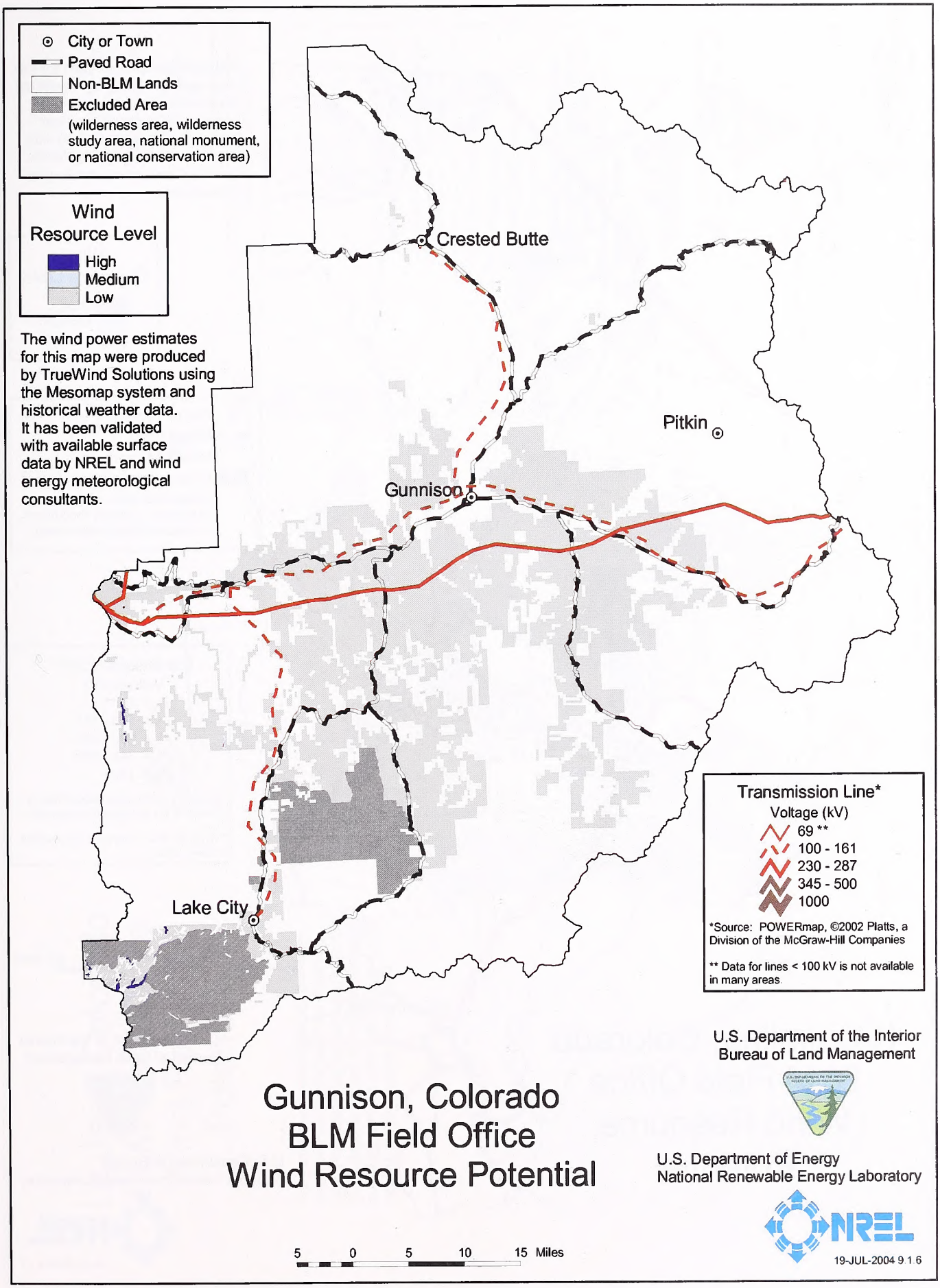
U.S. Department of the Interior
Bureau of Land Management

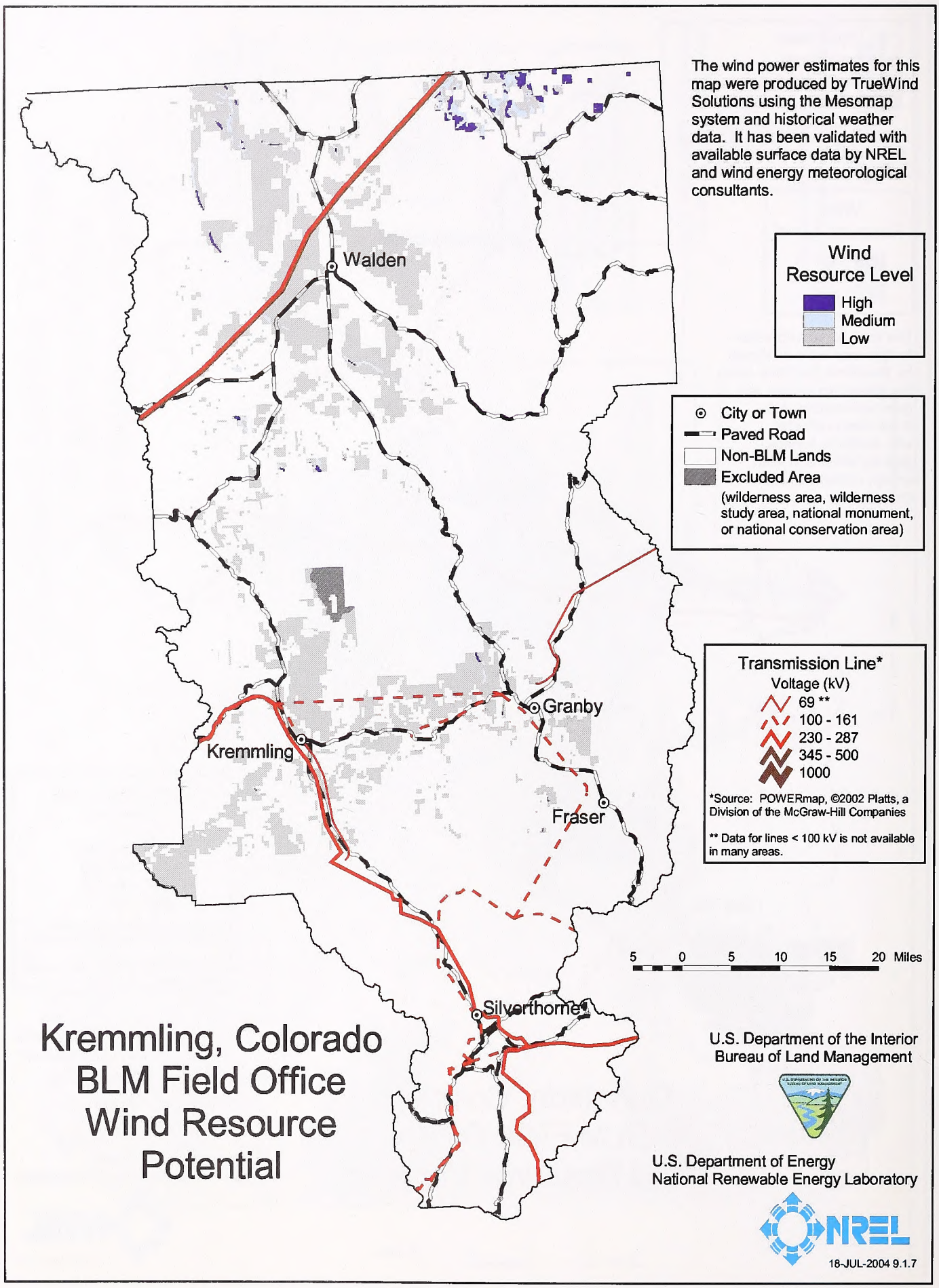
U.S. Department of Energy
National Renewable Energy Laboratory

NREL

18-JUL-2004 9.1.4

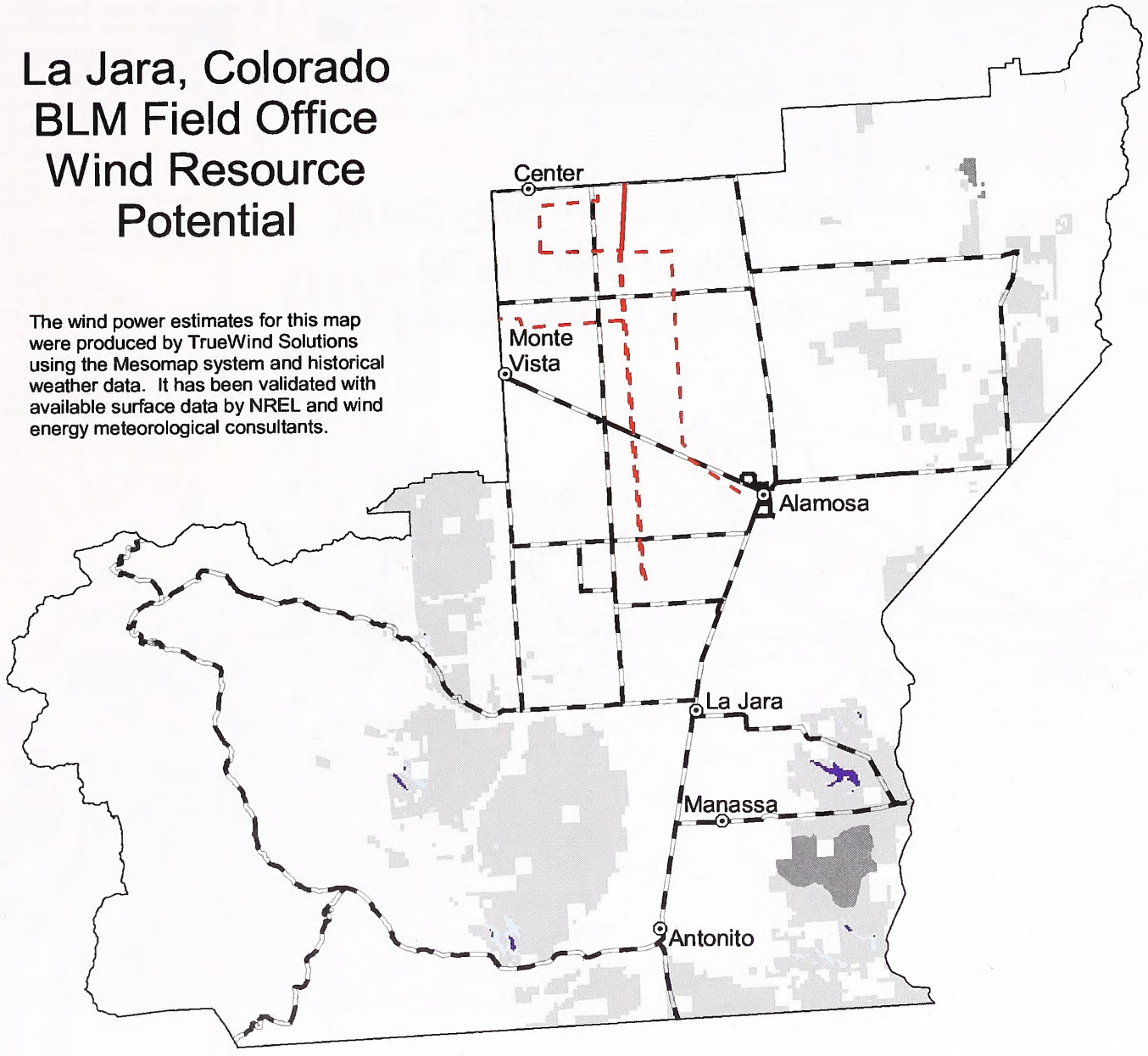

Grand Junction, Colorado
BLM Field Office
Wind Resource Potential
De Beque
Collbran
Fruita
Palisade
Grand Junction
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
10 0 10 20 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
18-JUL-2004 9:13


City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Crested Butte
Pitkin
Gunnison
Lake City
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
U.S. Department of the Interior
Bureau of Land Management
Gunnison, Colorado
BLM Field Office
Wind Resource Potential
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
5 0 5 10 15 Miles
19-JUL-2004 9:16


The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
Walden
Granby
Kremmling
Fraser
Silverthorne
5 0 5 10 15 20 Miles
Kremmling, Colorado
BLM Field Office
Wind Resource
Potential
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
18-JUL-2004 9.1.7

La Jara, Colorado BLM Field Office Wind Resource Potential

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.



Wind Resource Level
- High
- Medium
- Low

Transmission Line*
Voltage (kV)
- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

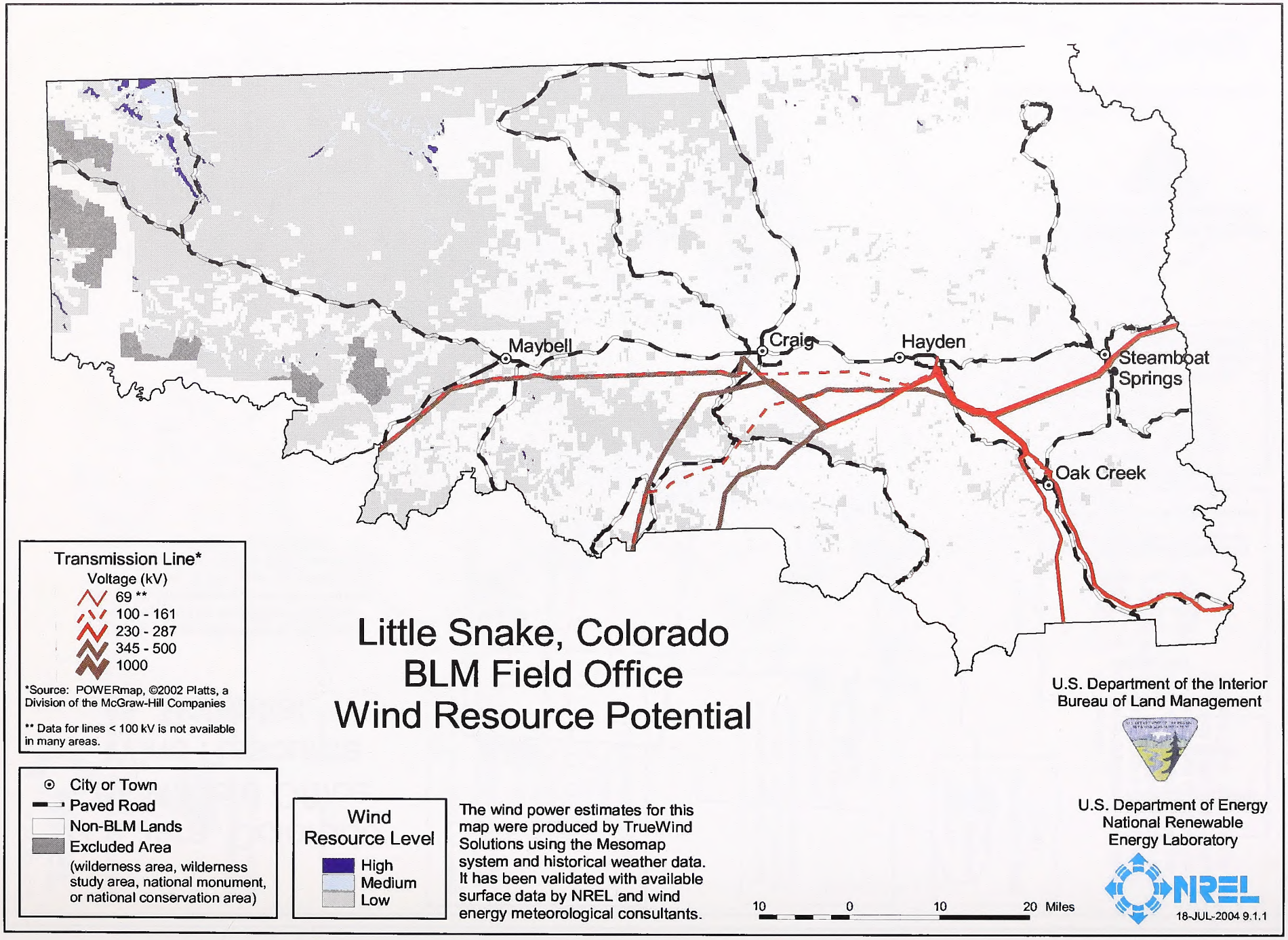
** Data for lines < 100 kV is not available in many areas.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

U.S. Department of the Interior
Bureau of Land Management

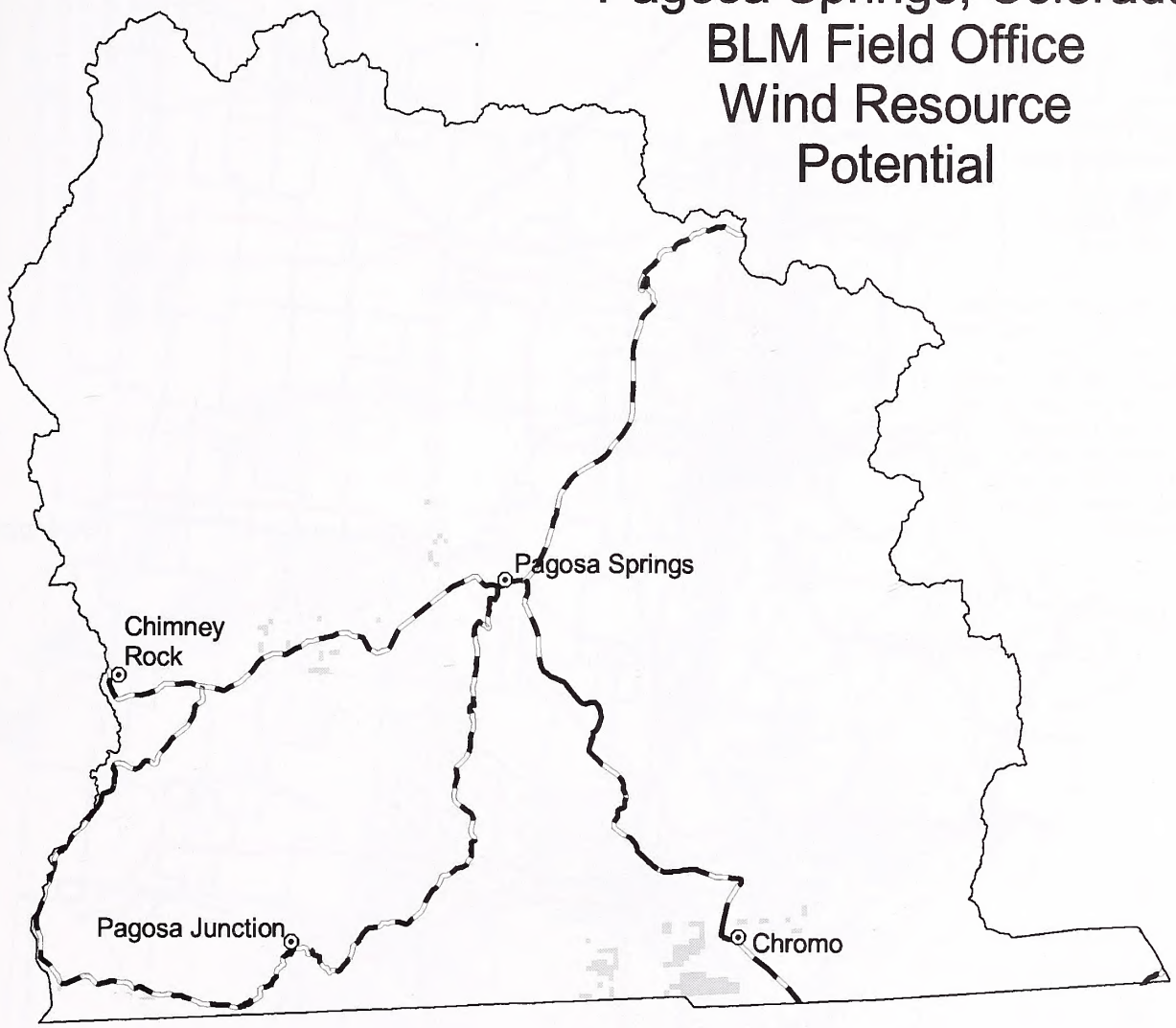
U.S. Department of Energy
National Renewable Energy Laboratory
NREL

18-JUL-2004 9.1.10



Little Snake, Colorado
BLM Field Office
Wind Resource Potential

Pagosa Springs, Colorado BLM Field Office Wind Resource Potential



The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

5 0 5 10 Miles

Wind Resource Level
- High
- Medium
- Low

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

Transmission Line*
Voltage (kV)
- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

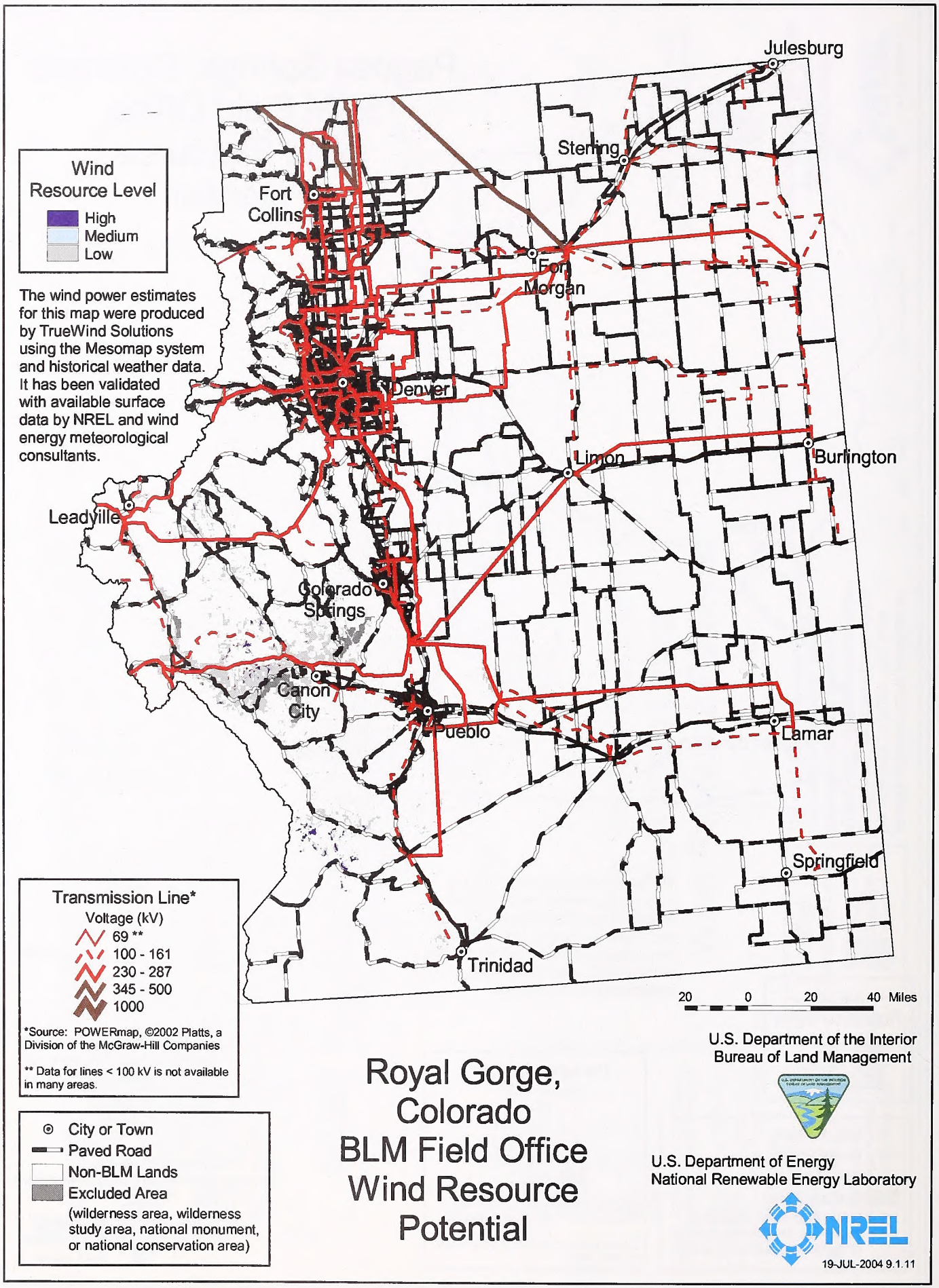
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

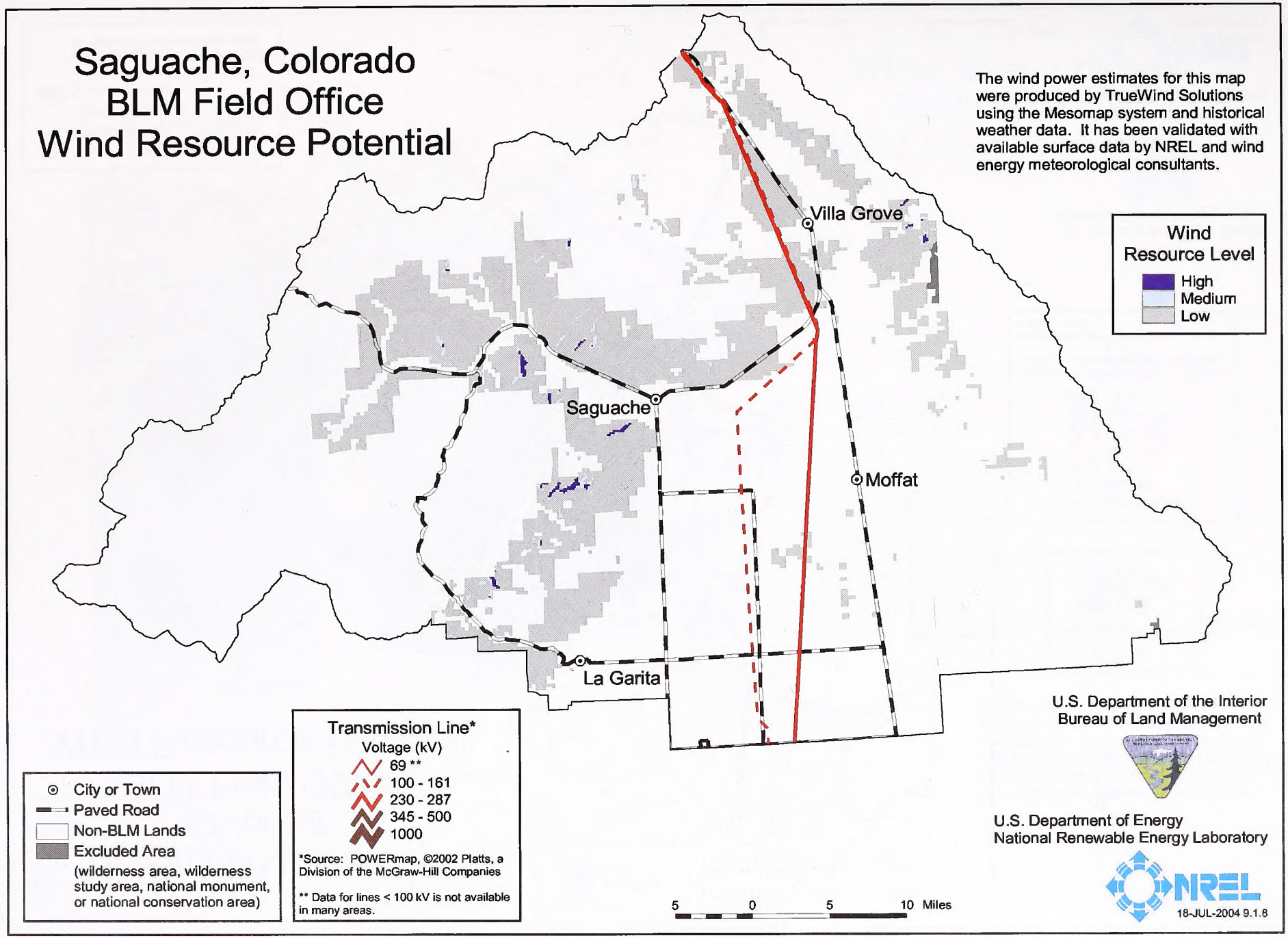
** Data for lines < 100 kV is not available in many areas.

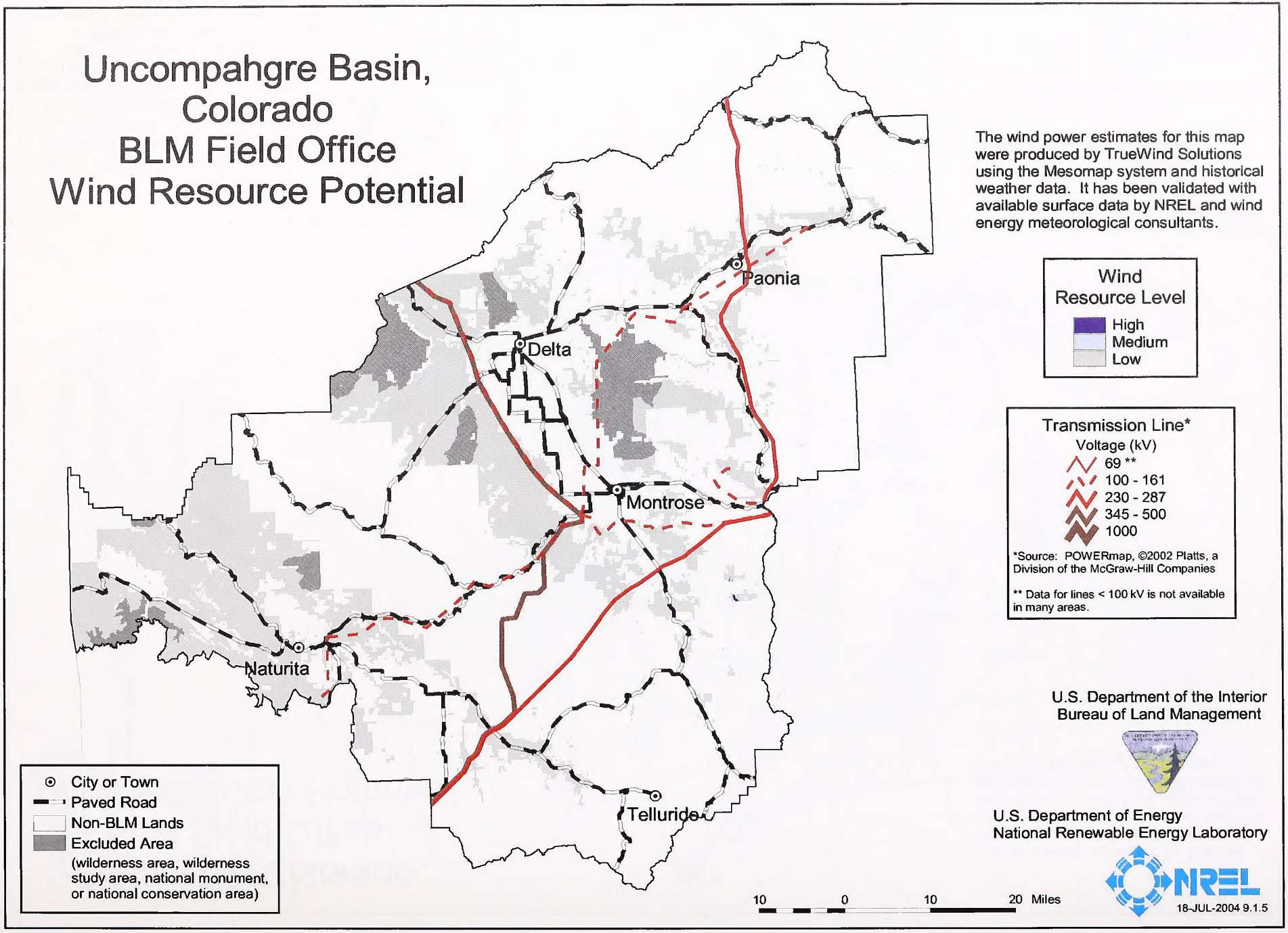
U.S. Department of the Interior
Bureau of Land Management

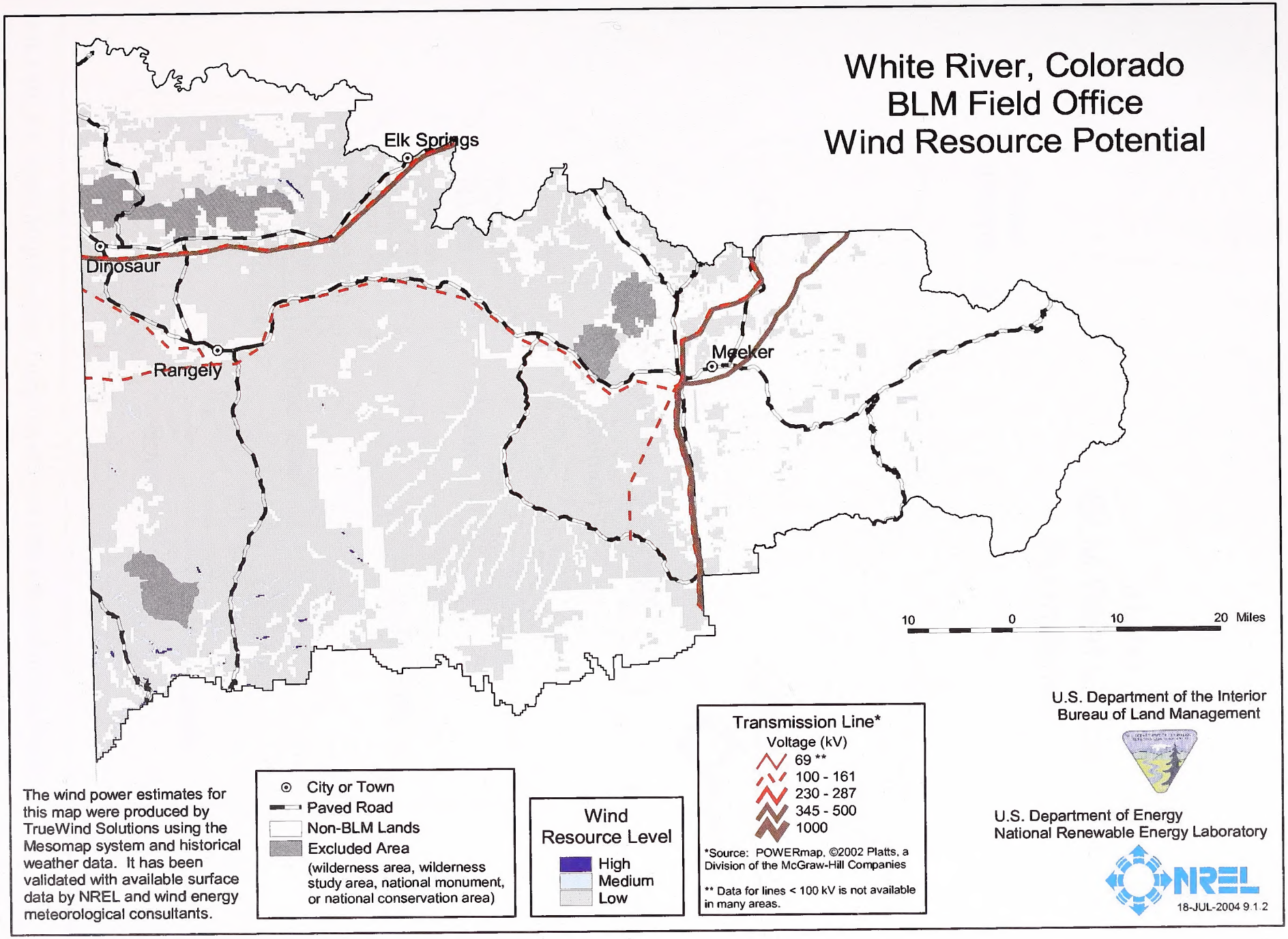
U.S. Department of Energy
National Renewable Energy Laboratory
NREL

18-JUL-2004 9.1.13


Julesburg
Sterling
Fort Collins
Fort Morgan
Denver
Limon
Burlington
Leadville
Colorado Springs
Canon City
Pueblo
Lamar
Springfield
Trinidad
Wind Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
20 0 20 40 Miles
Royal Gorge, Colorado BLM Field Office Wind Resource Potential
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
19-JUL-2004 9.1.11


Saguache, Colorado
BLM Field Office
Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Villa Grove
Saguache
Moffat
La Garita
Wind Resource Level
High
Medium
Low
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
5 0 5 10 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
18-JUL-2004 9.1.8


Uncompahgre Basin,
Colorado
BLM Field Office
Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
Paonia
Delta
Montrose
Naturita
Telluride
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
10 0 10 20 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
18-JUL-2004 9.1.5


White River, Colorado
BLM Field Office
Wind Resource Potential
Elk Springs
Dinosaur
Rangely
Meeker
10 0 10 20 Miles
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
18-JUL-2004 9.1.2

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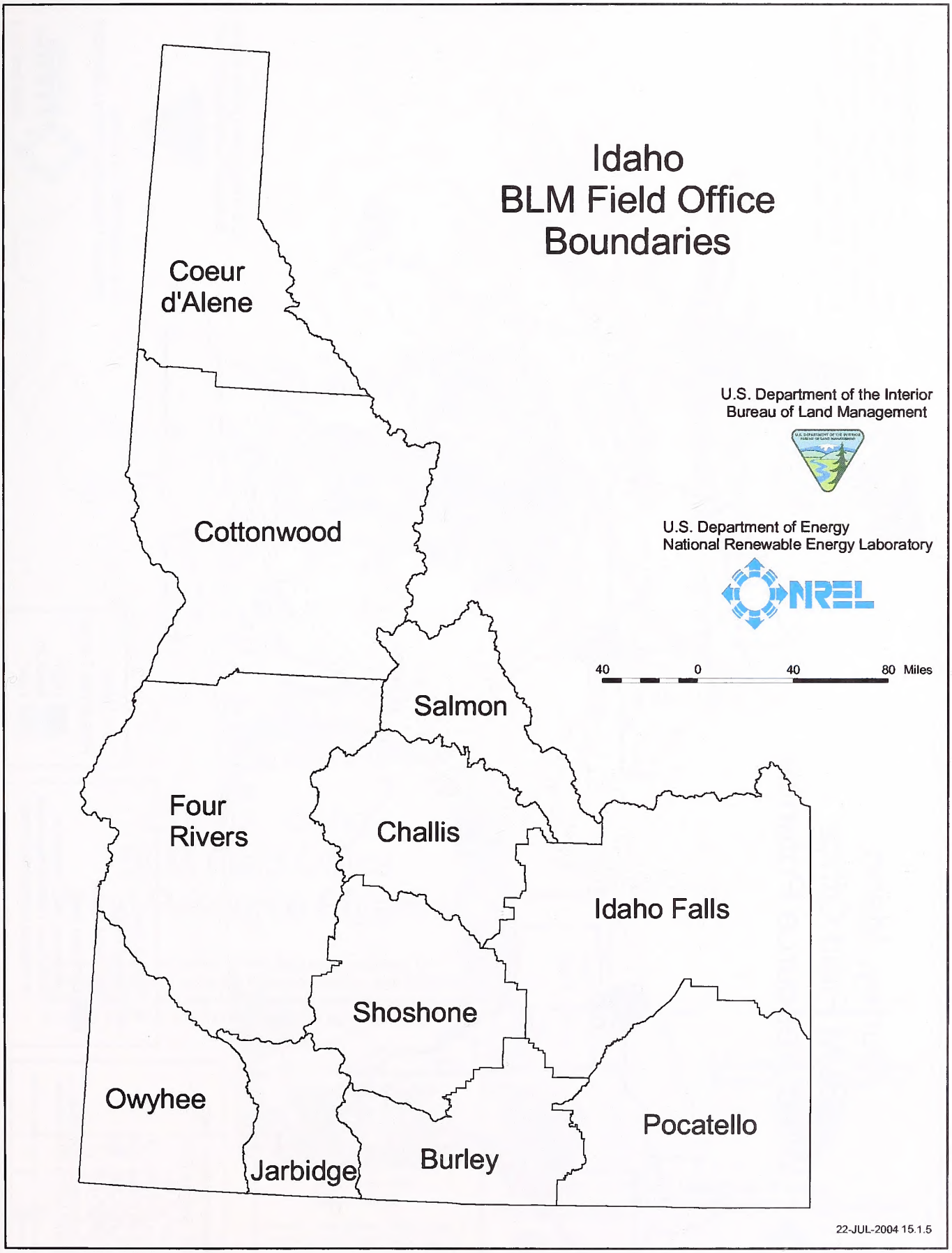
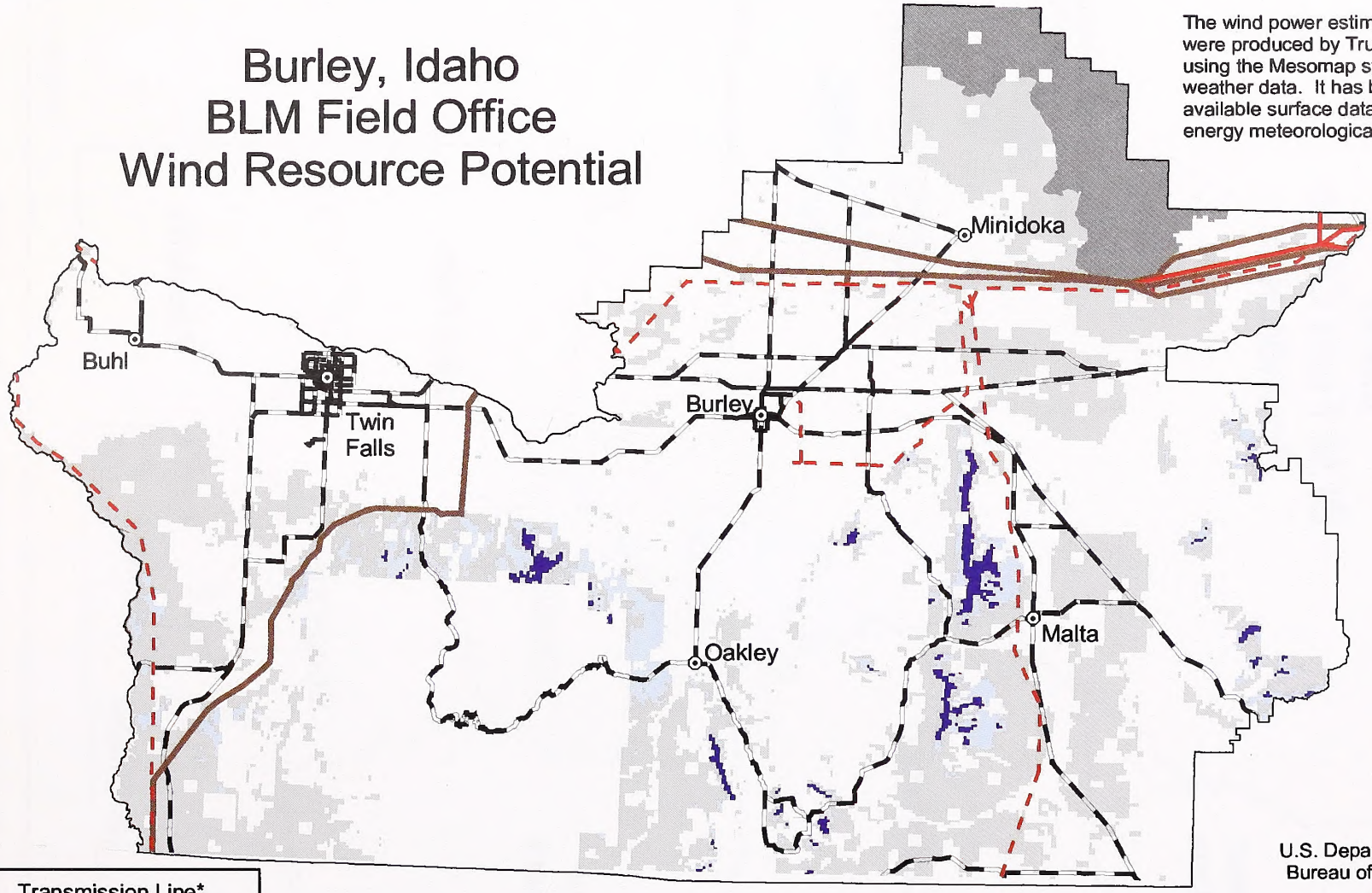


FIGURE B-6 Index Map Showing Locations of Field Office Boundaries in Idaho

Burley, Idaho
BLM Field Office
Wind Resource Potential

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.



Transmission Line*
Voltage (kV)
- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

** Data for lines < 100 kV is not available in many areas.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

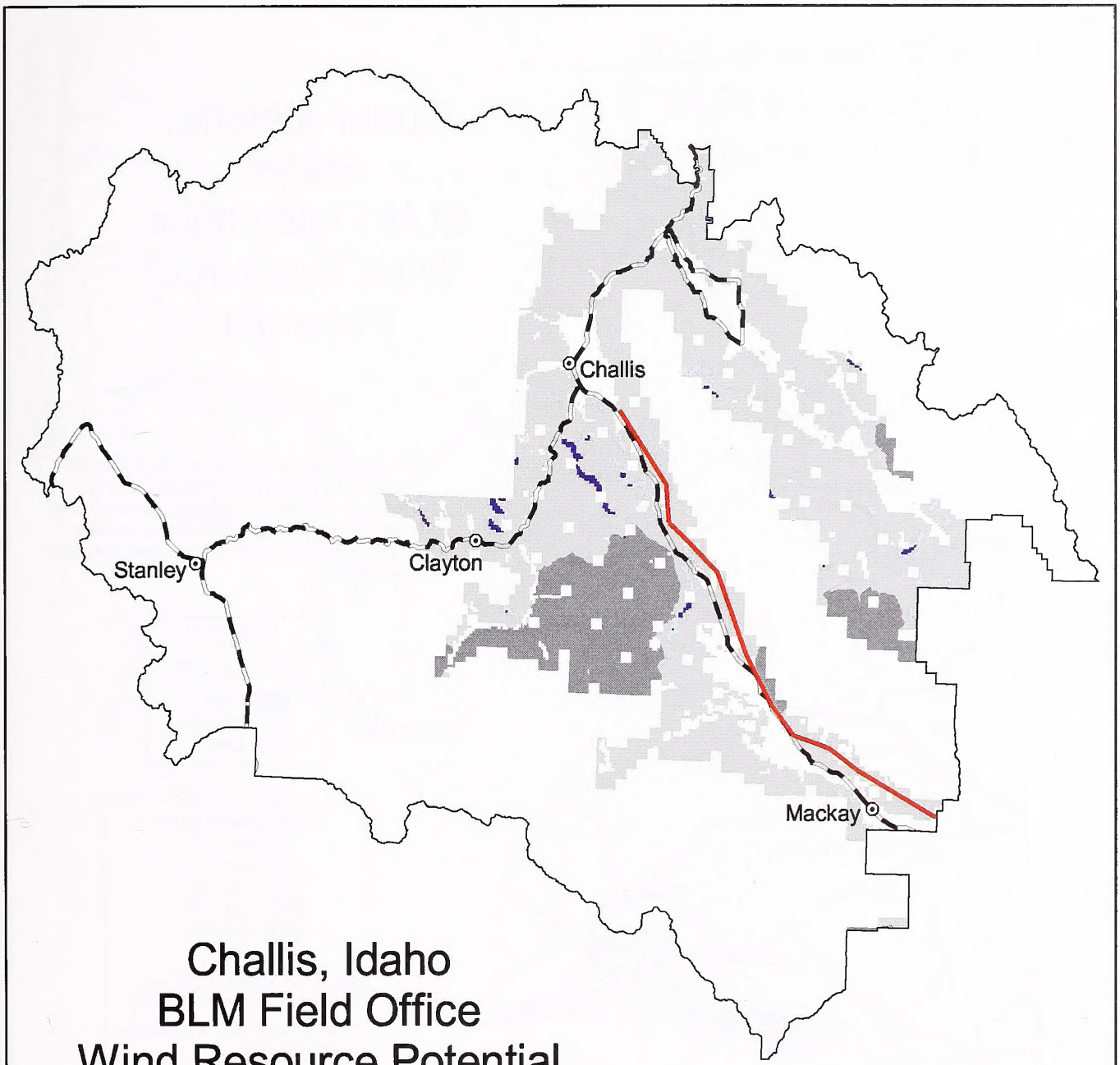
Wind Resource Level
- High
- Medium
- Low

U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

17-JUL-2004 12.1.8



Challis, Idaho
BLM Field Office
Wind Resource Potential

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

10 0 10 20 Miles

U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

11_MAY-2004 11.1.4

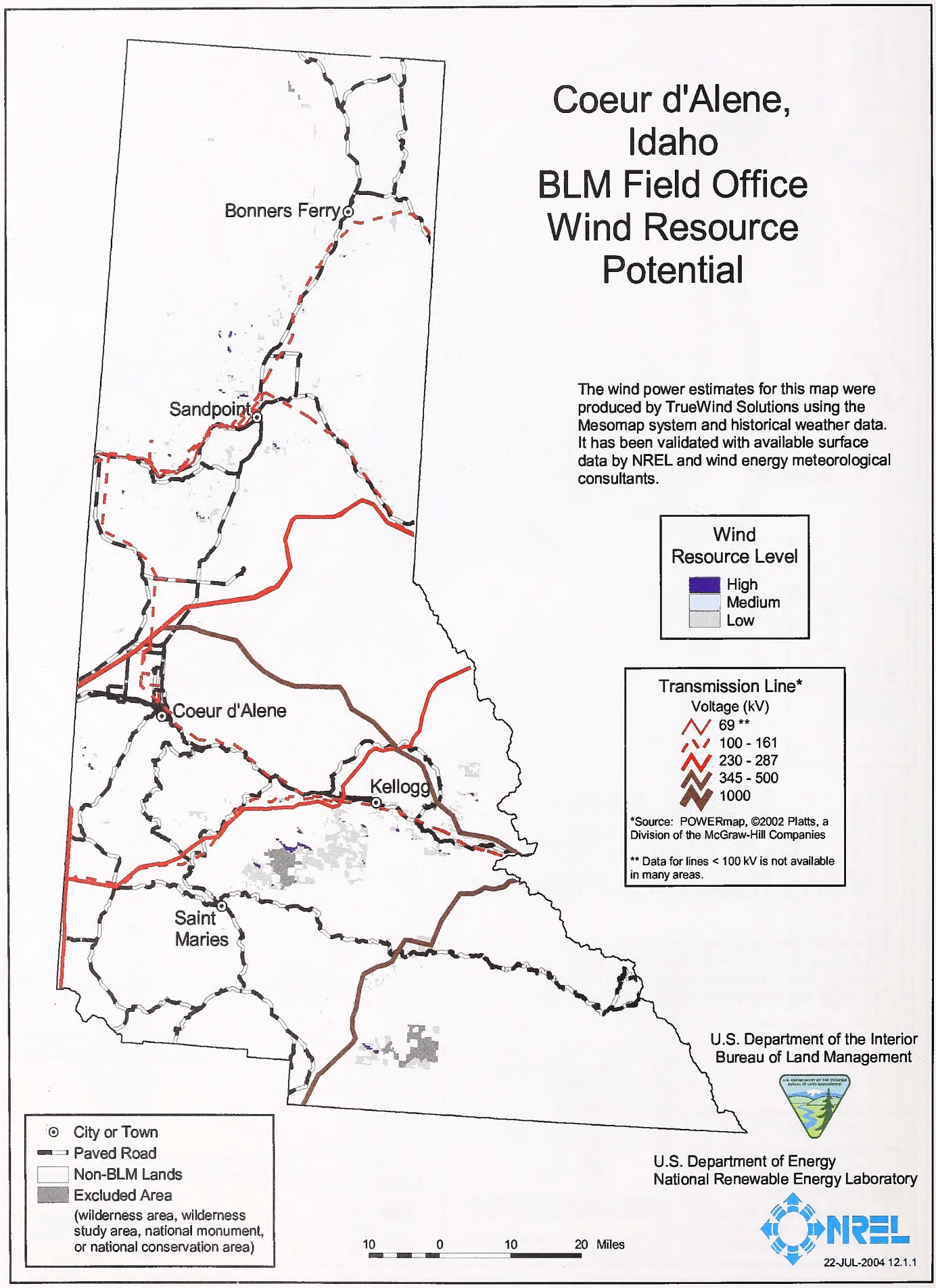
- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

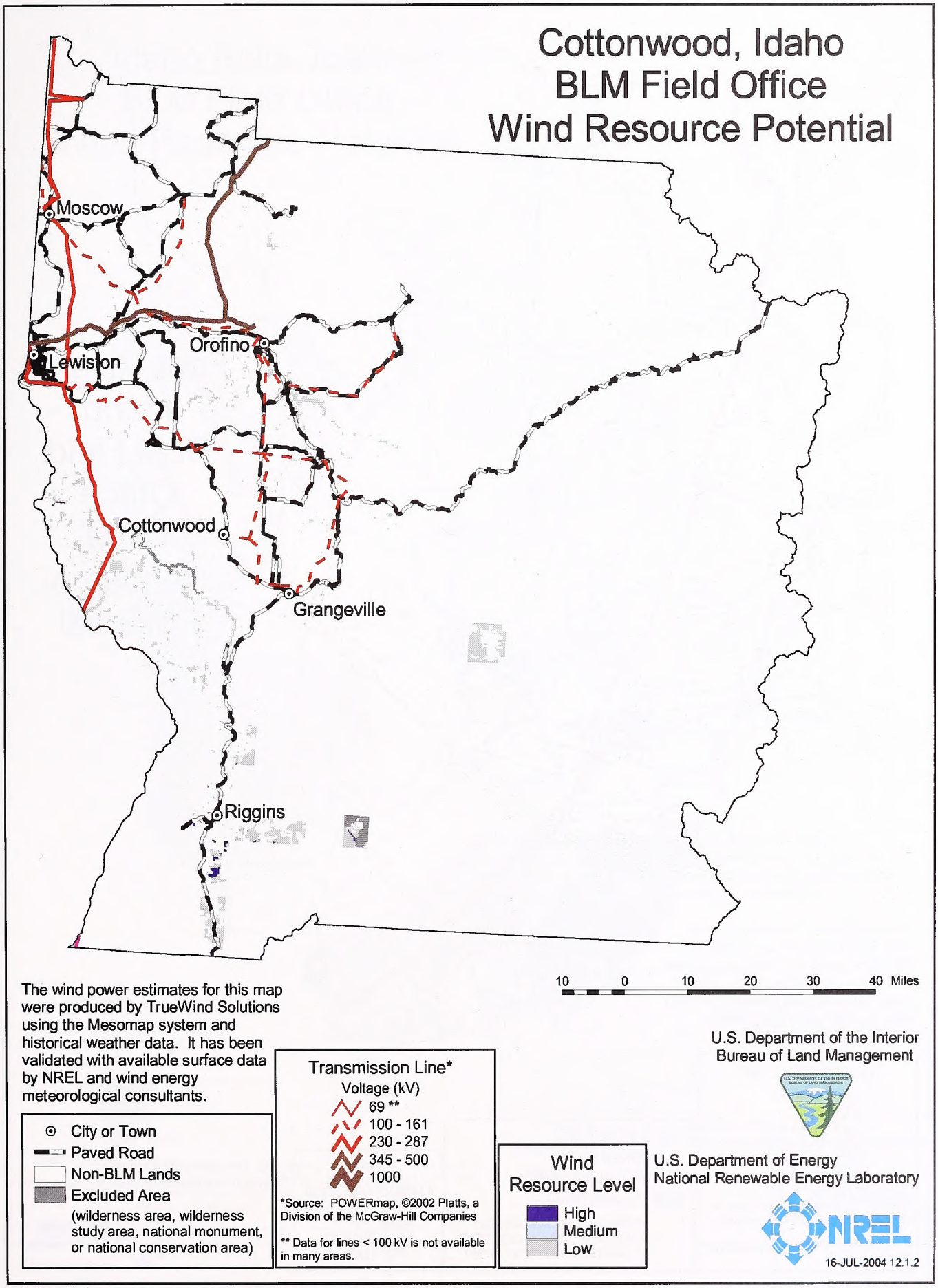
Transmission Line*
Voltage (kV)
- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

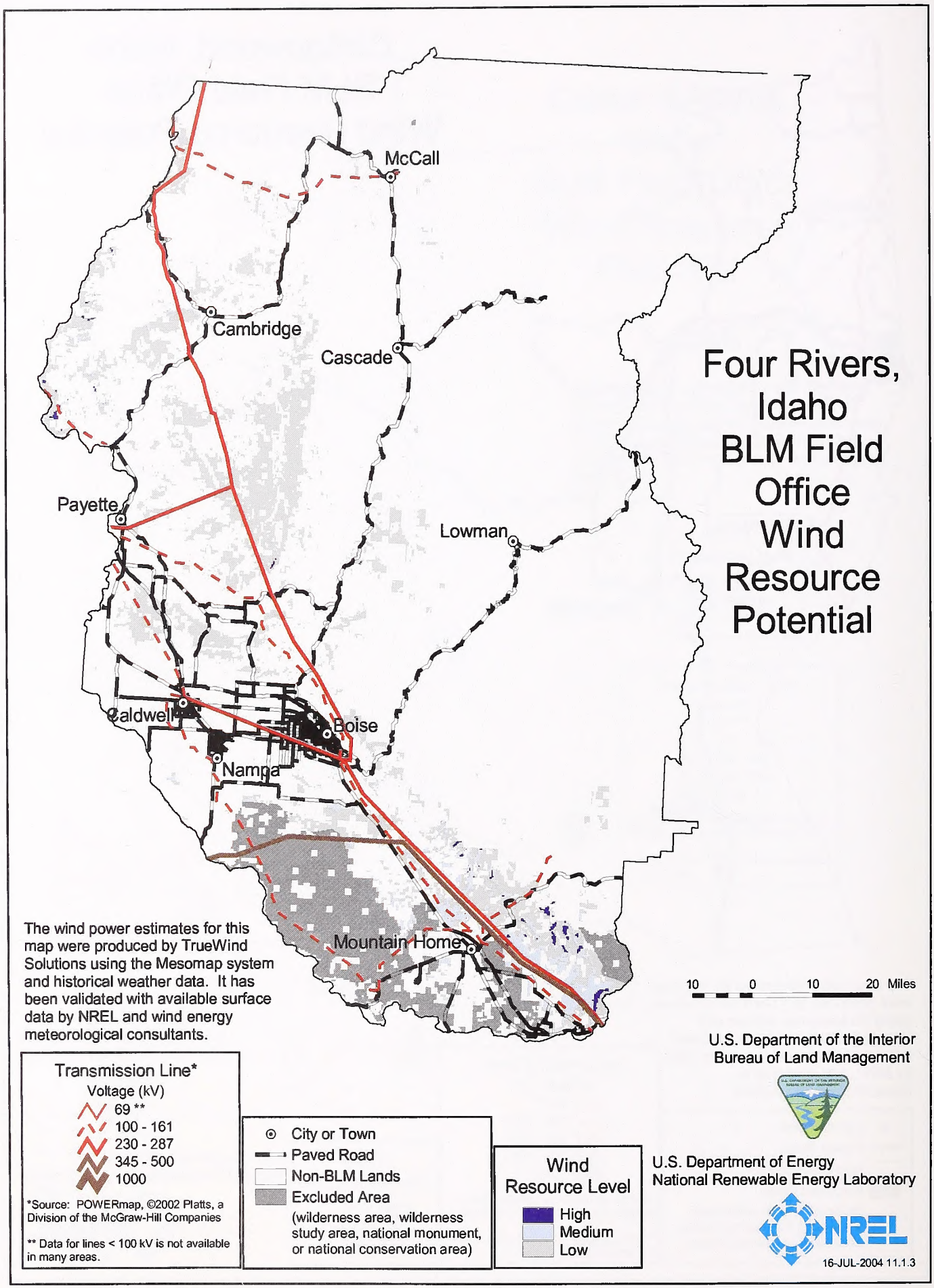
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

** Data for lines < 100 kV is not available in many areas.

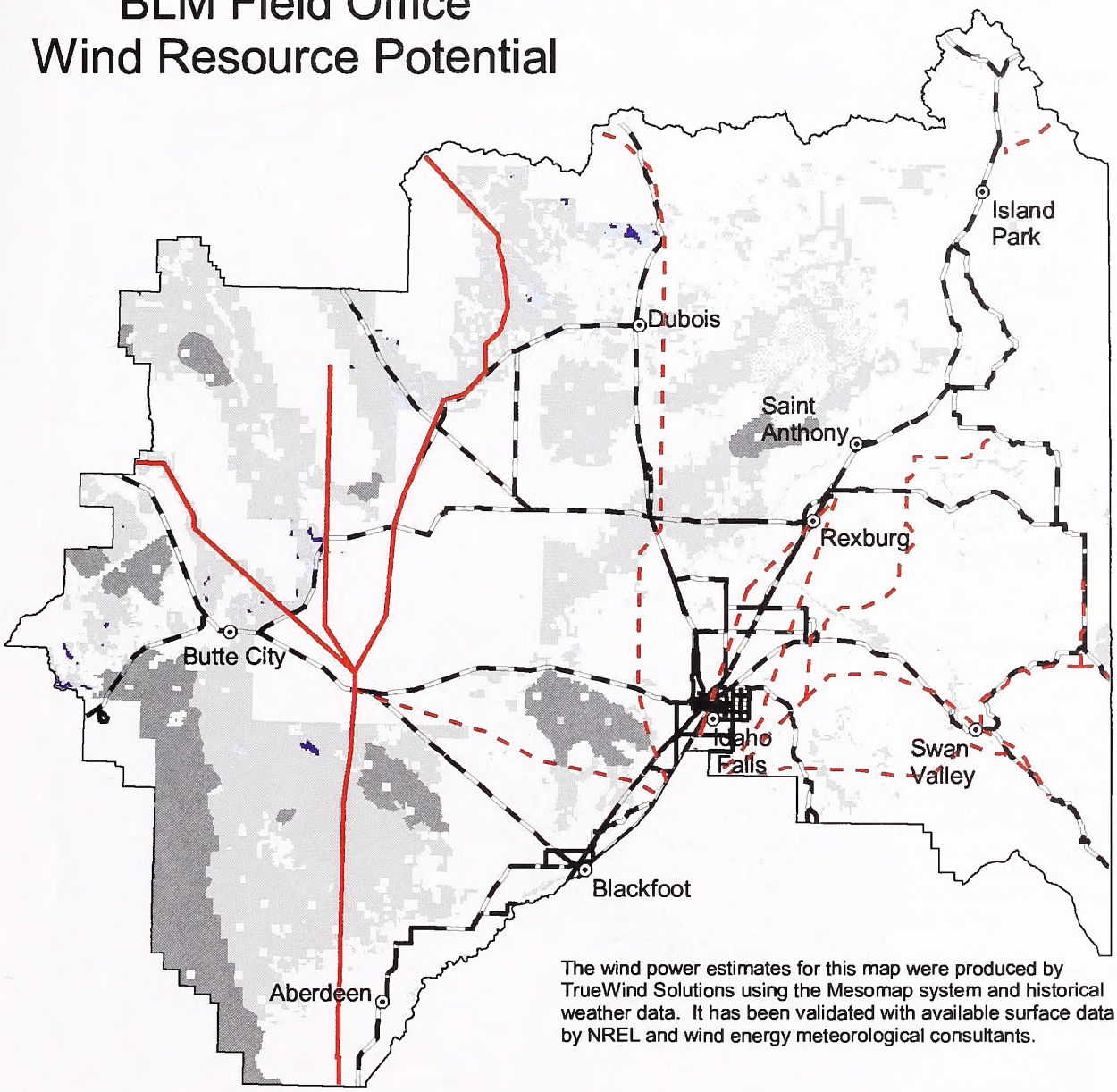
Wind Resource Level
- High
- Medium
- Low


Coeur d'Alene, Idaho BLM Field Office Wind Resource Potential
Bonners Ferry
Sandpoint
Coeur d'Alene
Kellogg
Saint Maries
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
10 0 10 20 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
22-JUL-2004 12.1.1


Cottonwood, Idaho
BLM Field Office
Wind Resource Potential
Moscow
Lewiston
Orofino
Cottonwood
Grangeville
Riggins
10 0 10 20 30 40 Miles
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
Wind Resource Level
High
Medium
Low
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
16-JUL-2004 12.1.2


McCall
Cambridge
Cascade
Payette
Lowman
Caldwell
Boise
Nampa
Mountain Home
Four Rivers, Idaho BLM Field Office Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
10 0 10 20 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
16-JUL-2004 11.1.3
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind Resource Level
High
Medium
Low

Idaho Falls, Idaho
BLM Field Office
Wind Resource Potential



The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

10 0 10 20 30 40 Miles

U.S. Department of the Interior
Bureau of Land Management

City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)

Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

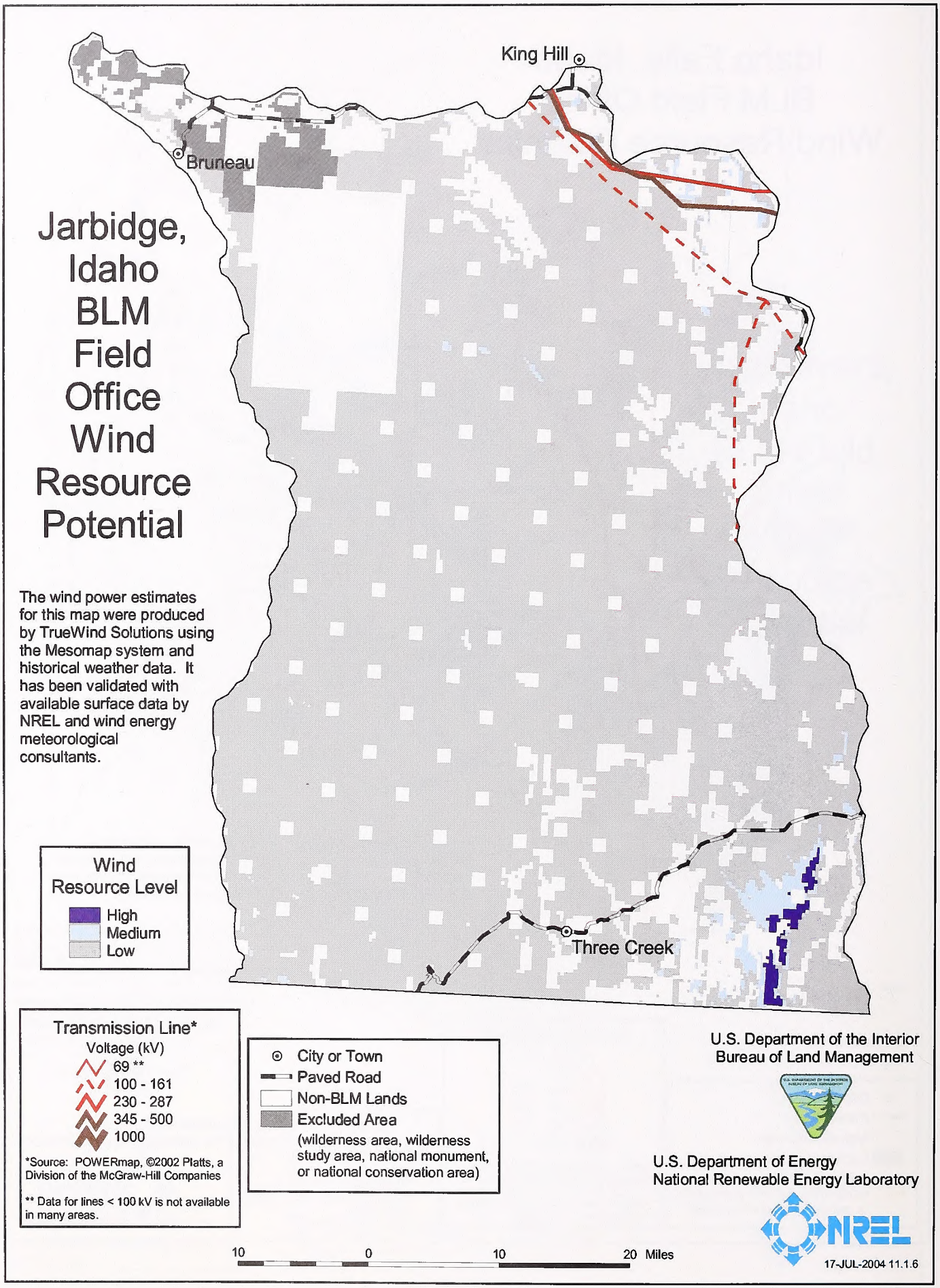
** Data for lines < 100 kV is not available in many areas.

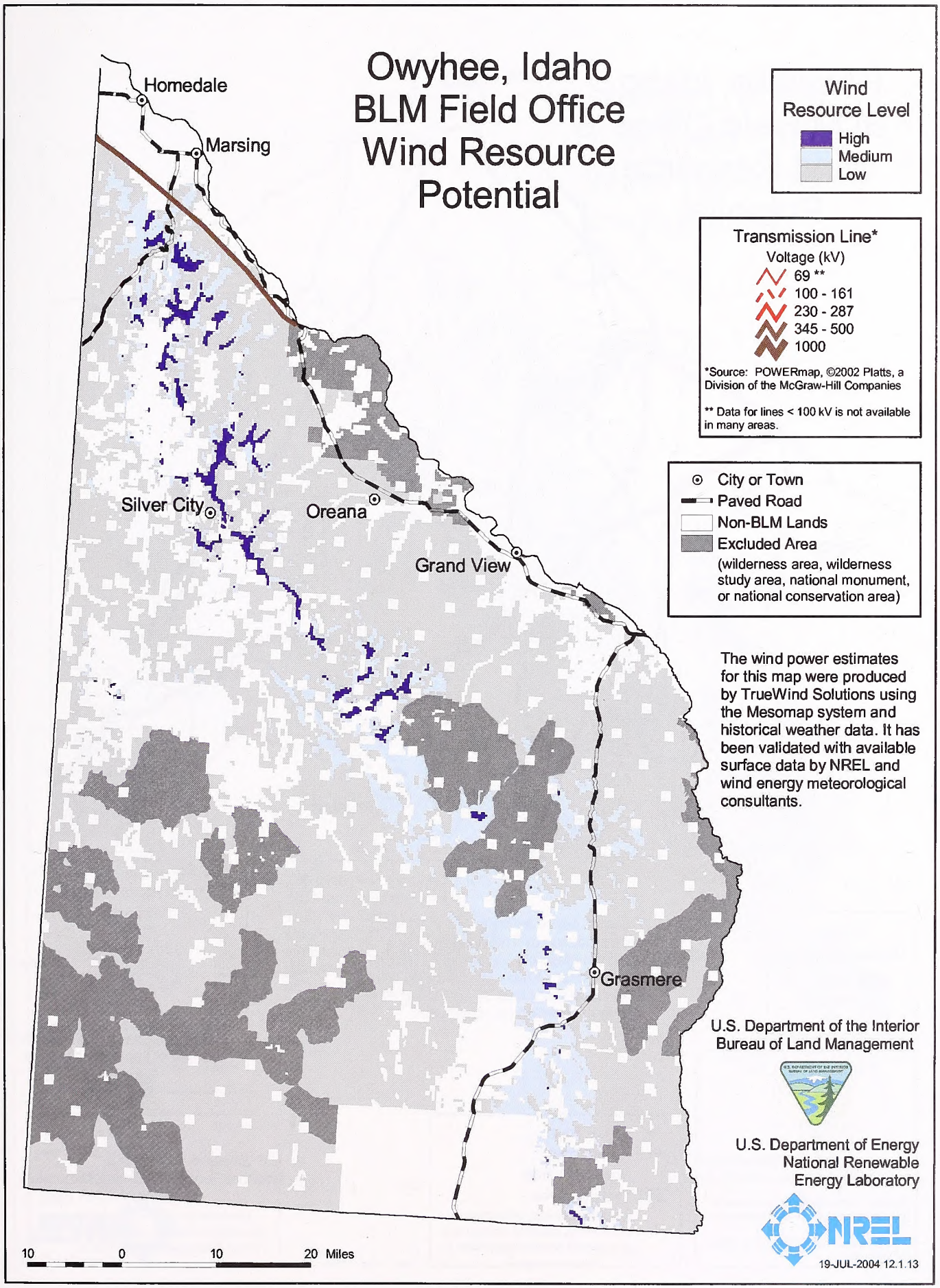
Wind Resource Level
High
Medium
Low

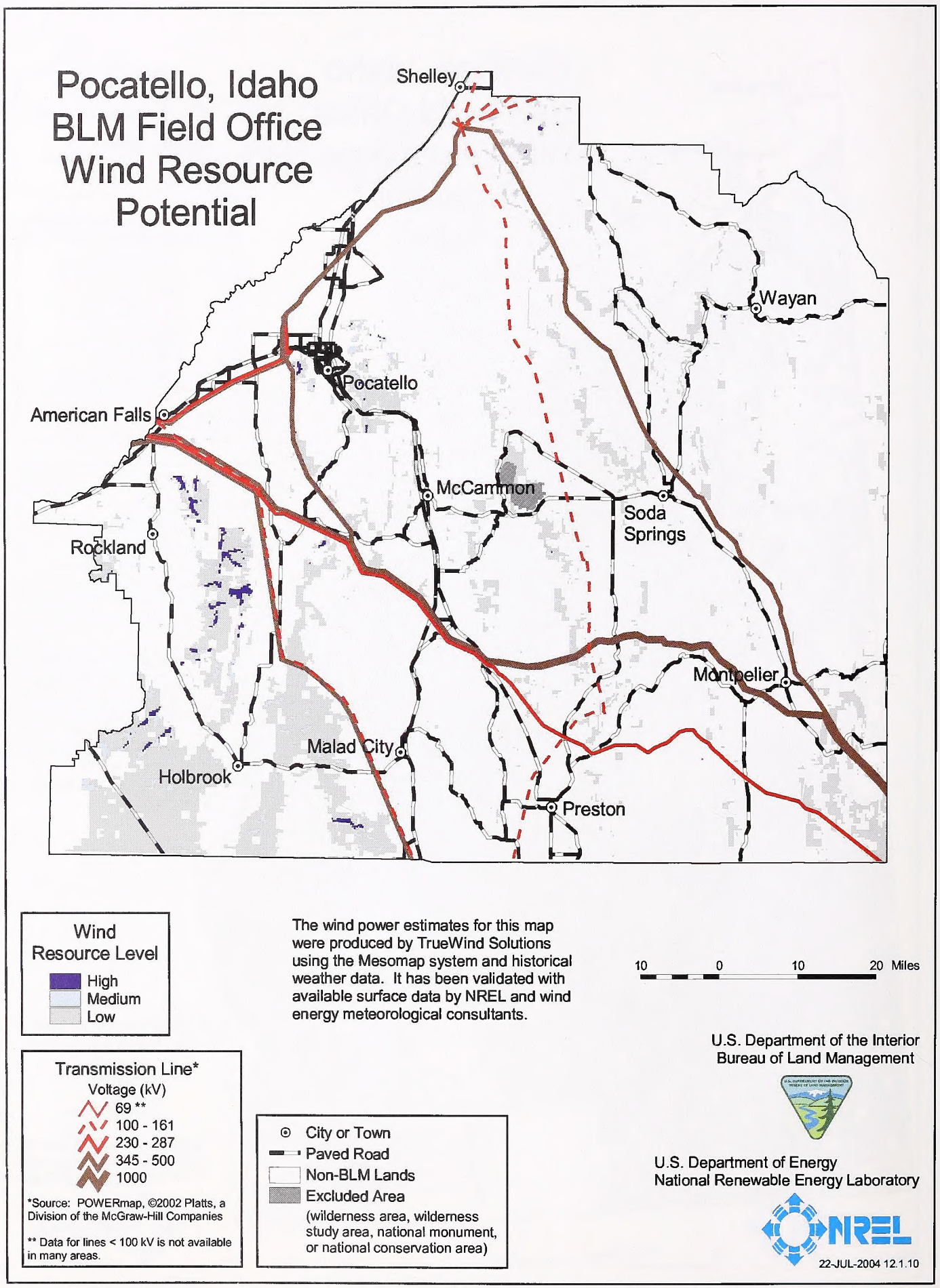
U.S. Department of Energy
National Renewable Energy Laboratory

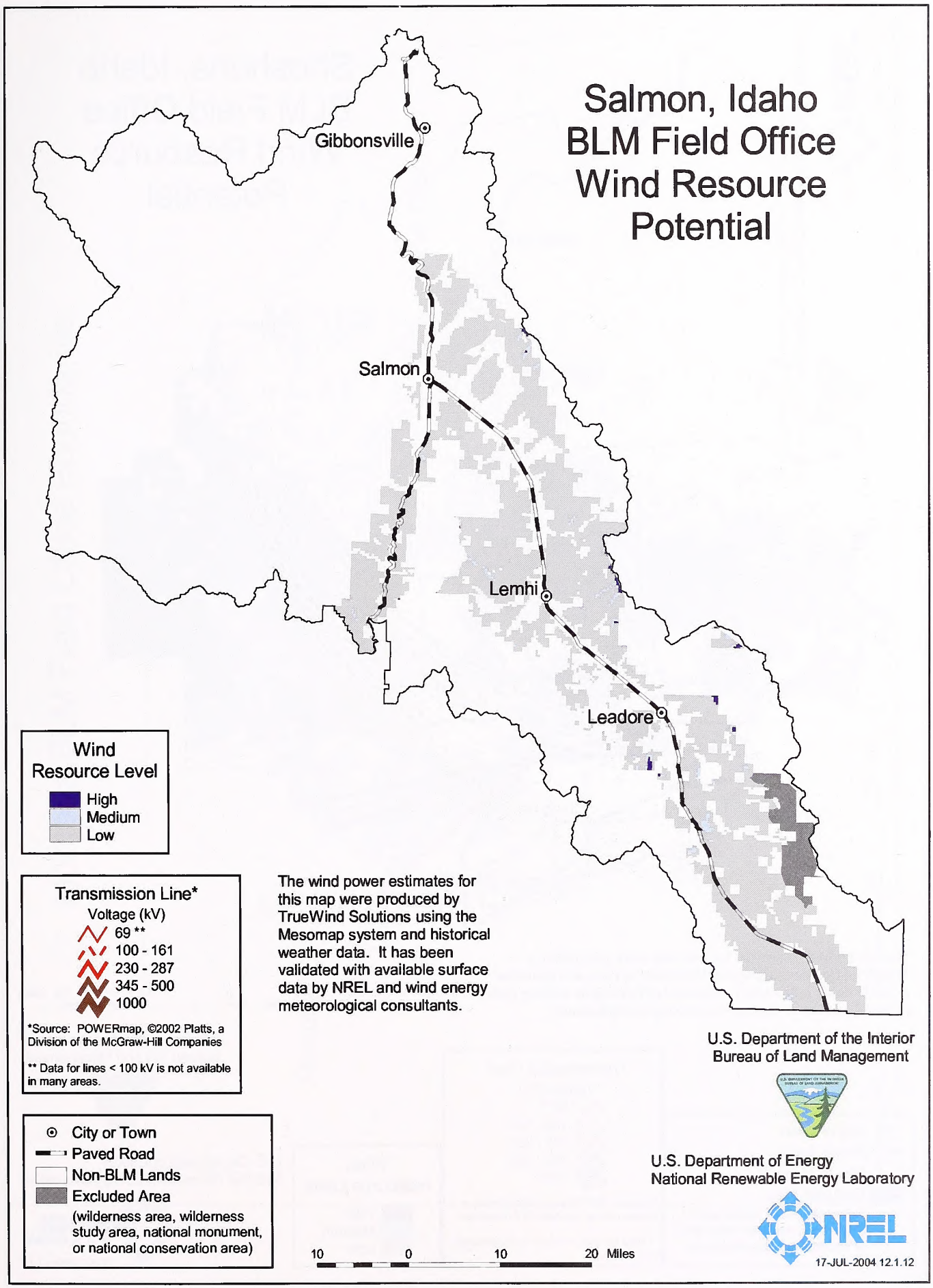
NREL

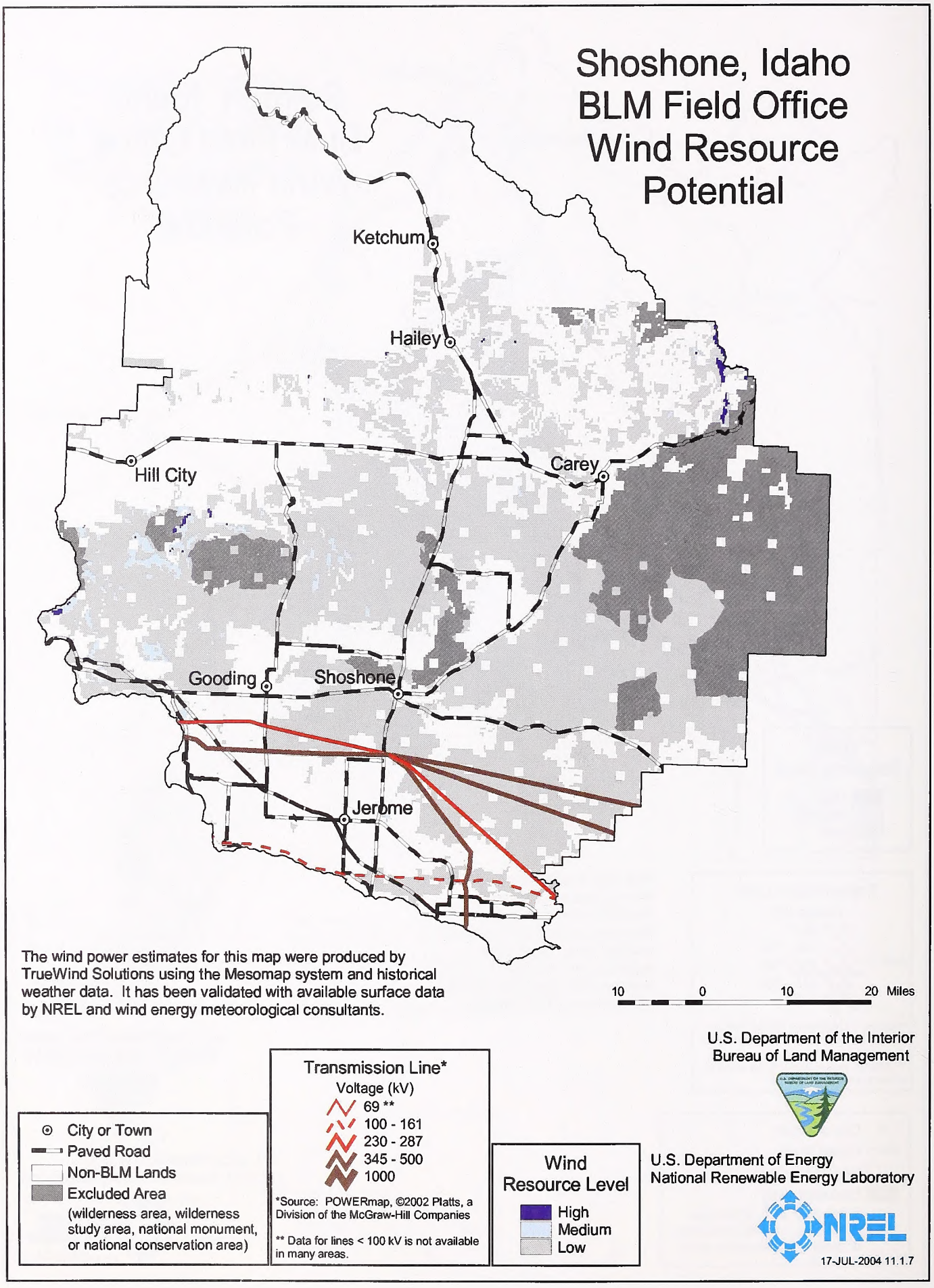
19-JUL-2004 12:1.9


King Hill
Bruneau
Three Creek
Jarbidge, Idaho BLM Field Office Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
10 0 10 20 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
17-JUL-2004 11.1.6


Owyhee, Idaho
BLM Field Office
Wind Resource
Potential
Homedale
Marsing
Silver City
Oreana
Grand View
Grasmere
Wind
Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
10 0 10 20 Miles
19-JUL-2004 12.1.13


Pocatello, Idaho
BLM Field Office
Wind Resource
Potential
Shelley
Wayan
Pocatello
American Falls
McCammon
Soda
Springs
Rockland
Montpelier
Malad City
Holbrook
Preston
Wind
Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
10 0 10 20 Miles
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
22-JUL-2004 12.1.10


Salmon, Idaho
BLM Field Office
Wind Resource
Potential
Gibbonsville
Salmon
Lemhi
Leadore
Wind
Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
10 0 10 20 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
17-JUL-2004 12.1.12


Shoshone, Idaho
BLM Field Office
Wind Resource
Potential
Ketchum
Hailey
Hill City
Carey
Gooding
Shoshone
Jerome
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
10 0 10 20 Miles
U.S. Department of the Interior
Bureau of Land Management
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
Wind Resource Level
High
Medium
Low
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
17-JUL-2004 11.1.7

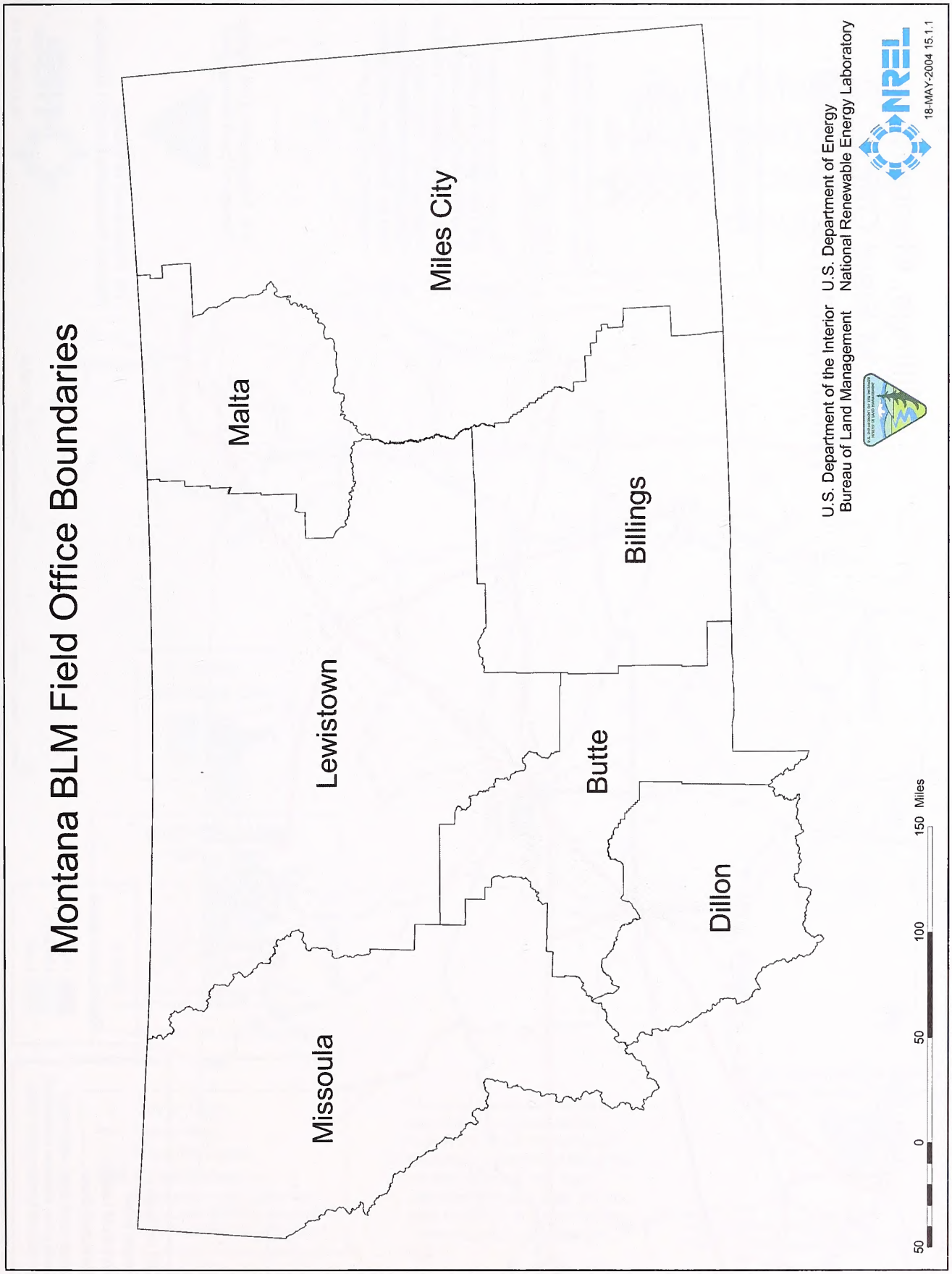
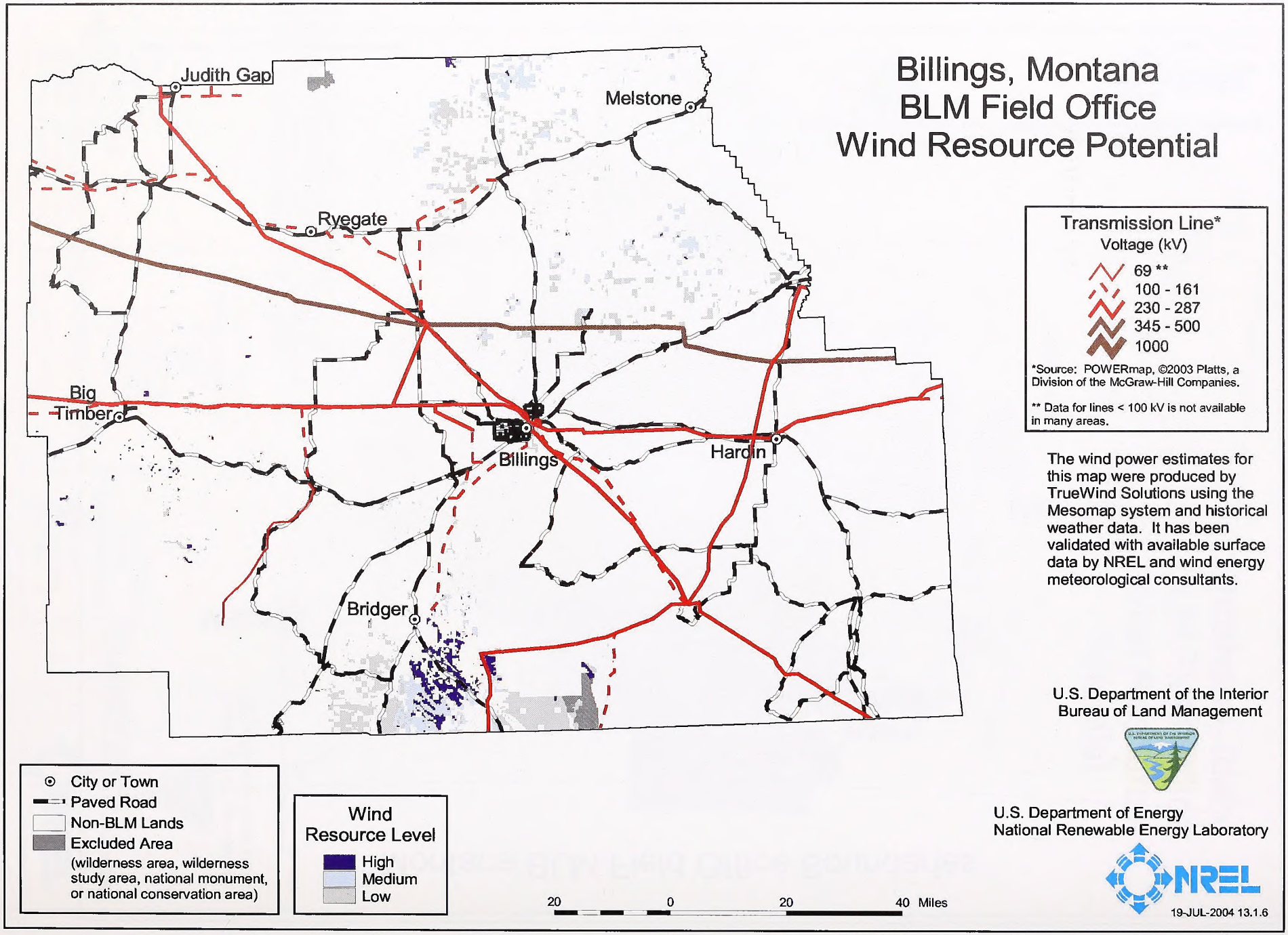
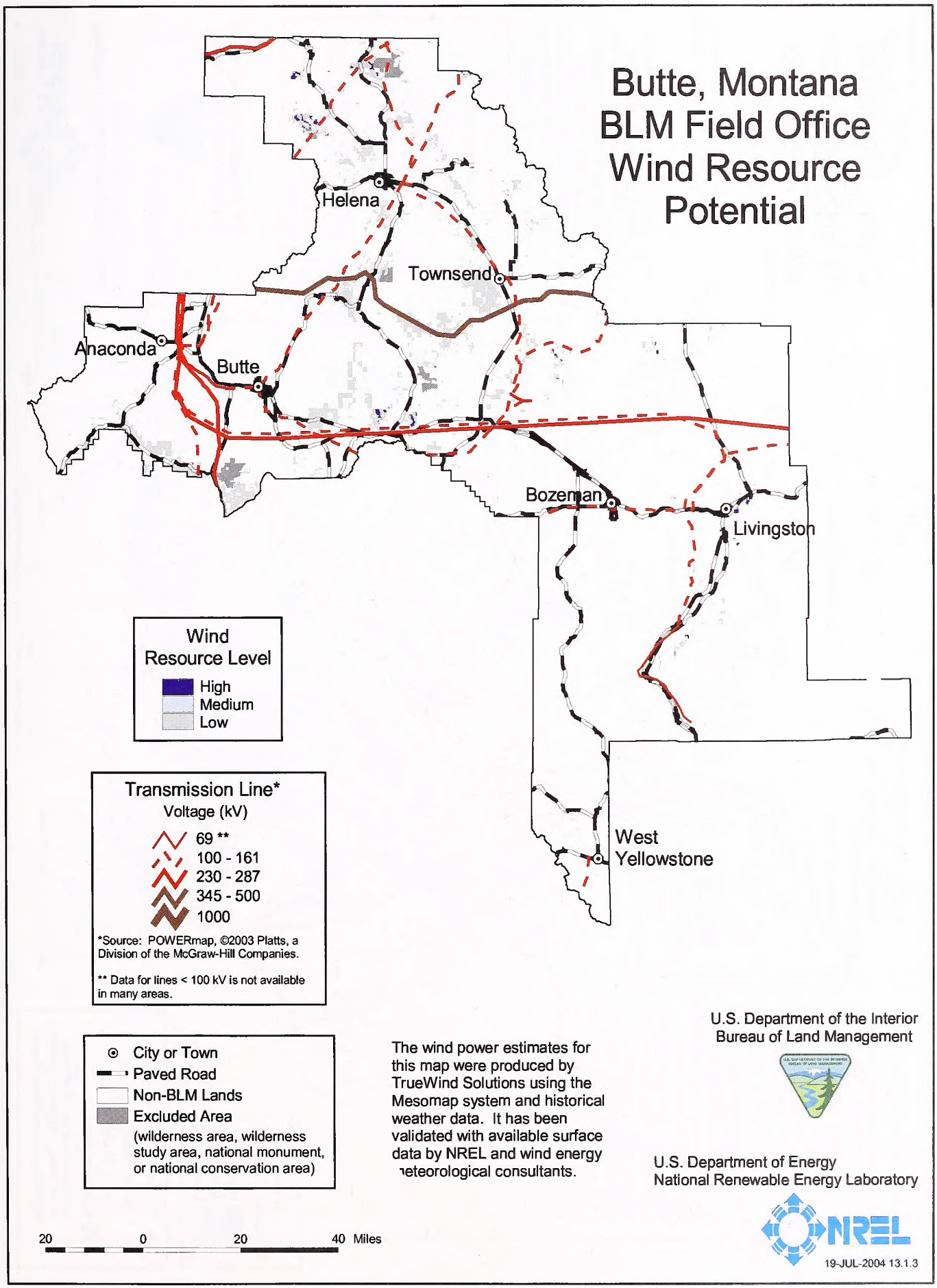
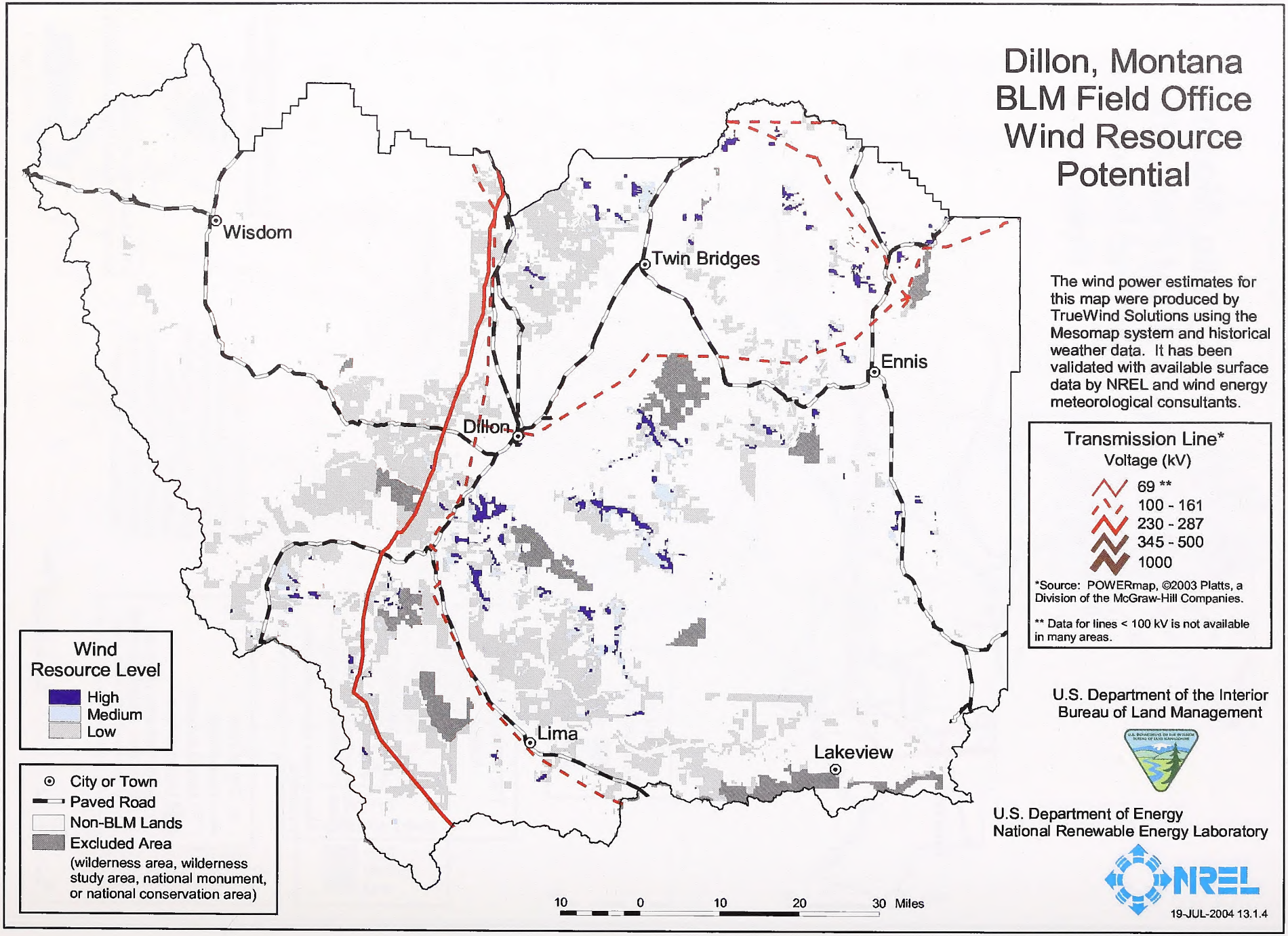
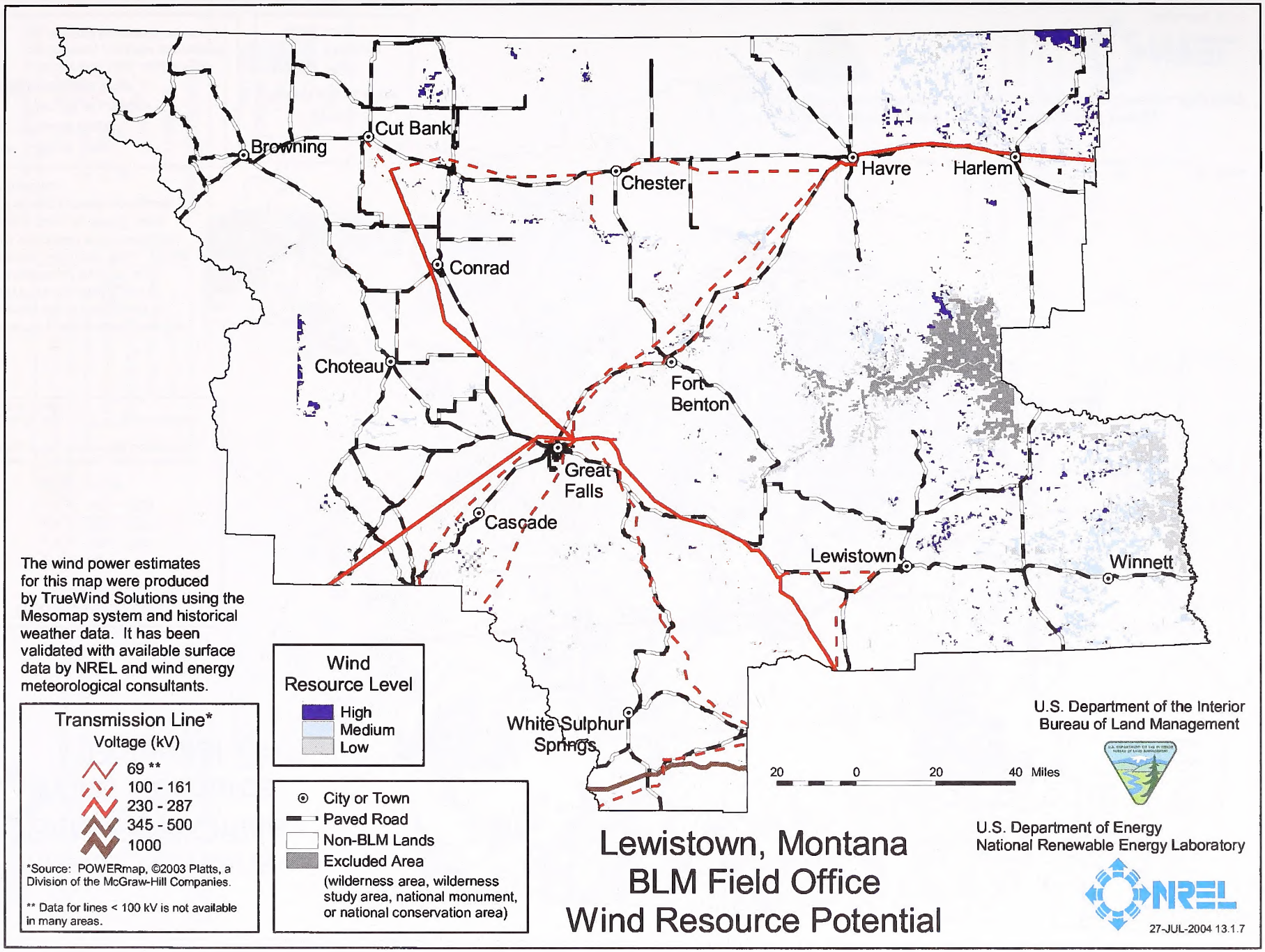


FIGURE B-7 Index Map Showing Locations of Field Office Boundaries in Montana

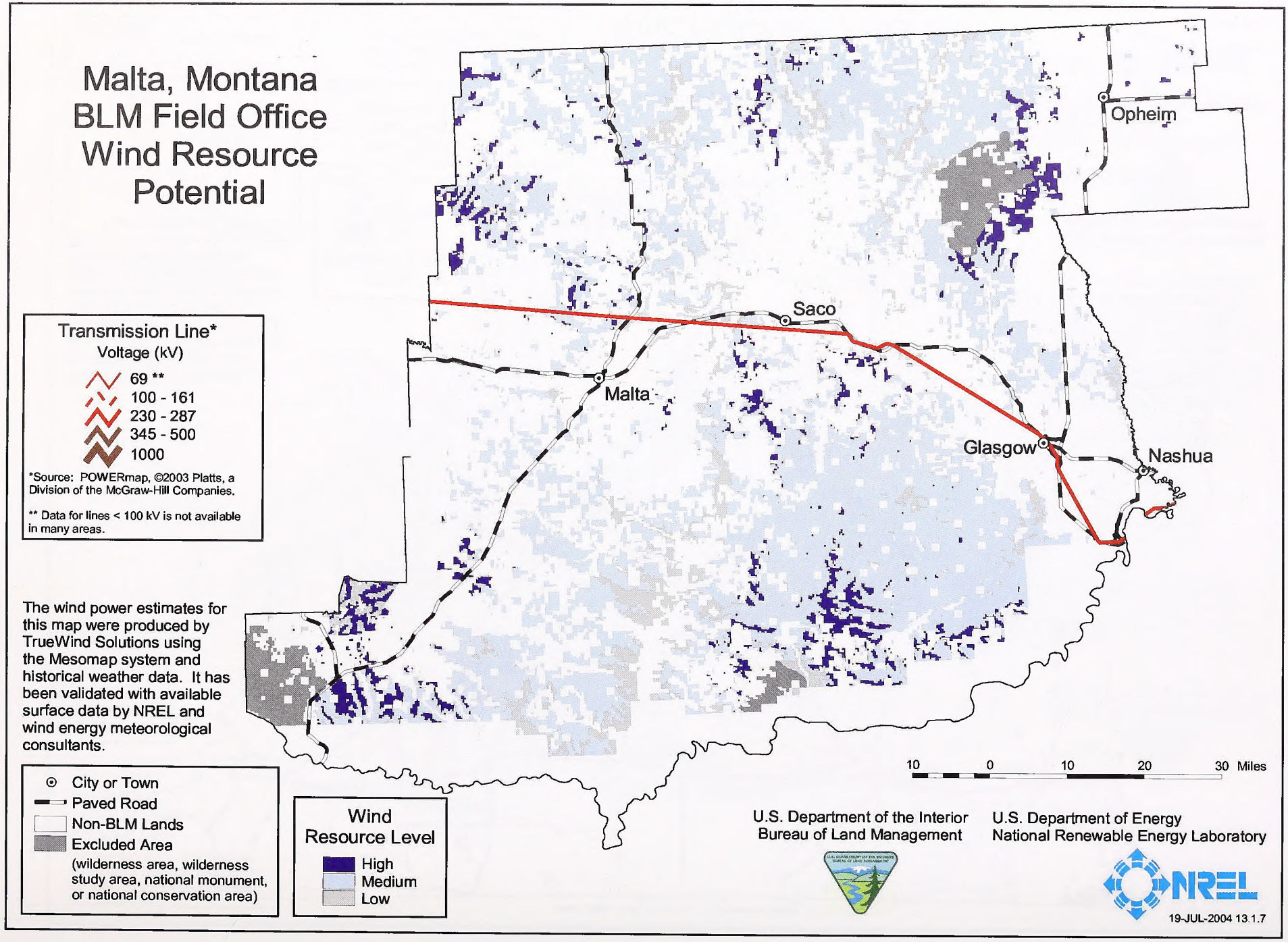

Billings, Montana
BLM Field Office
Wind Resource Potential
Judith Gap
Melstone
Ryegate
Big Timber
Billings
Hardin
Bridger
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind Resource Level
High
Medium
Low
20 0 20 40 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
19-JUL-2004 13.1.6

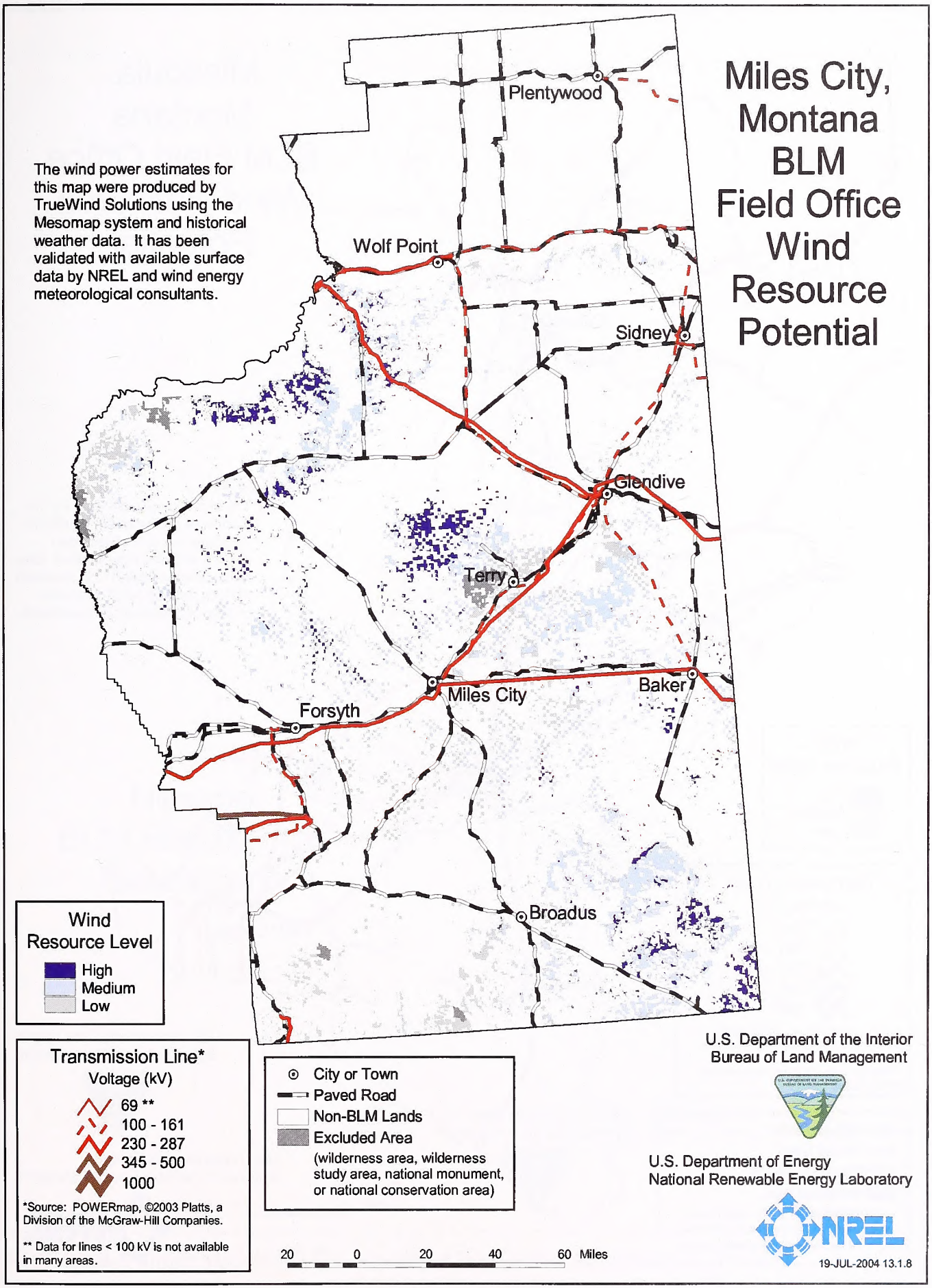

Butte, Montana
BLM Field Office
Wind Resource
Potential
Helena
Townsend
Anaconda
Butte
Bozeman
Livingston
West
Yellowstone
Wind
Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
20 0 20 40 Miles
19-JUL-2004 13.1.3

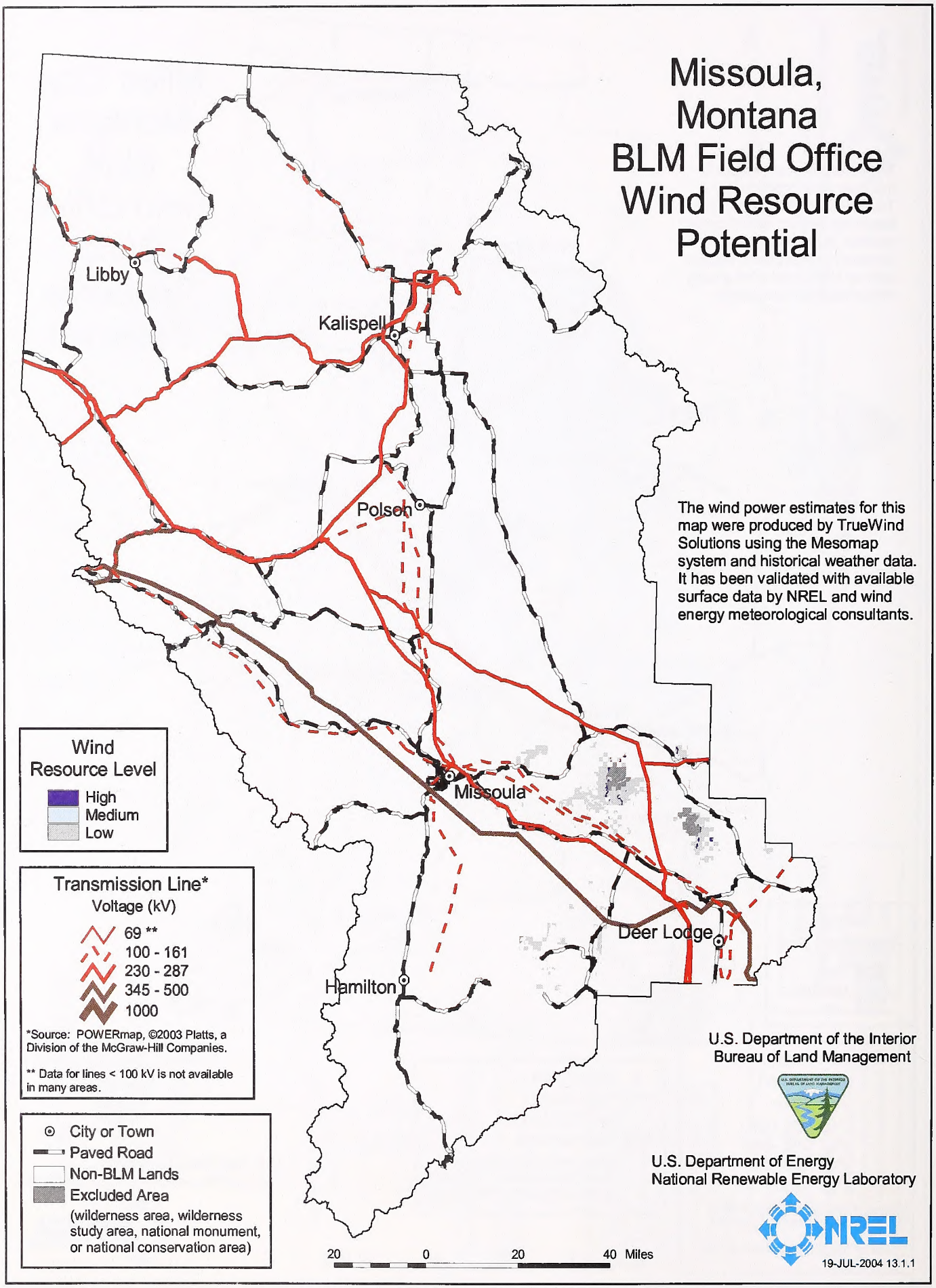

Dillon, Montana
BLM Field Office
Wind Resource
Potential
Wisdom
Twin Bridges
Ennis
Dillon
Lima
Lakeview
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
Wind Resource Level
High
Medium
Low
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
10 0 10 20 30 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
19-JUL-2004 13.1.4


Browning
Cut Bank
Chester
Havre
Harlem
Conrad
Choteau
Fort Benton
Great Falls
Cascade
Lewistown
Winnett
White Sulphur Springs
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
Wind Resource Level
High
Medium
Low
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
20 0 20 40 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
27-JUL-2004 13.1.7
Lewistown, Montana
BLM Field Office
Wind Resource Potential

Malta, Montana BLM Field Office Wind Resource Potential




Miles City, Montana BLM Field Office Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Plentywood
Wolf Point
Sidney
Glendive
Terry
Miles City
Baker
Forsyth
Broadus
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
20 0 20 40 60 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
19-JUL-2004 13.1.8


Missoula, Montana BLM Field Office Wind Resource Potential
Libby
Kalispell
Polson
Missoula
Deer Lodge
Hamilton
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2003 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
20 0 20 40 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
19-JUL-2004 13.1.1

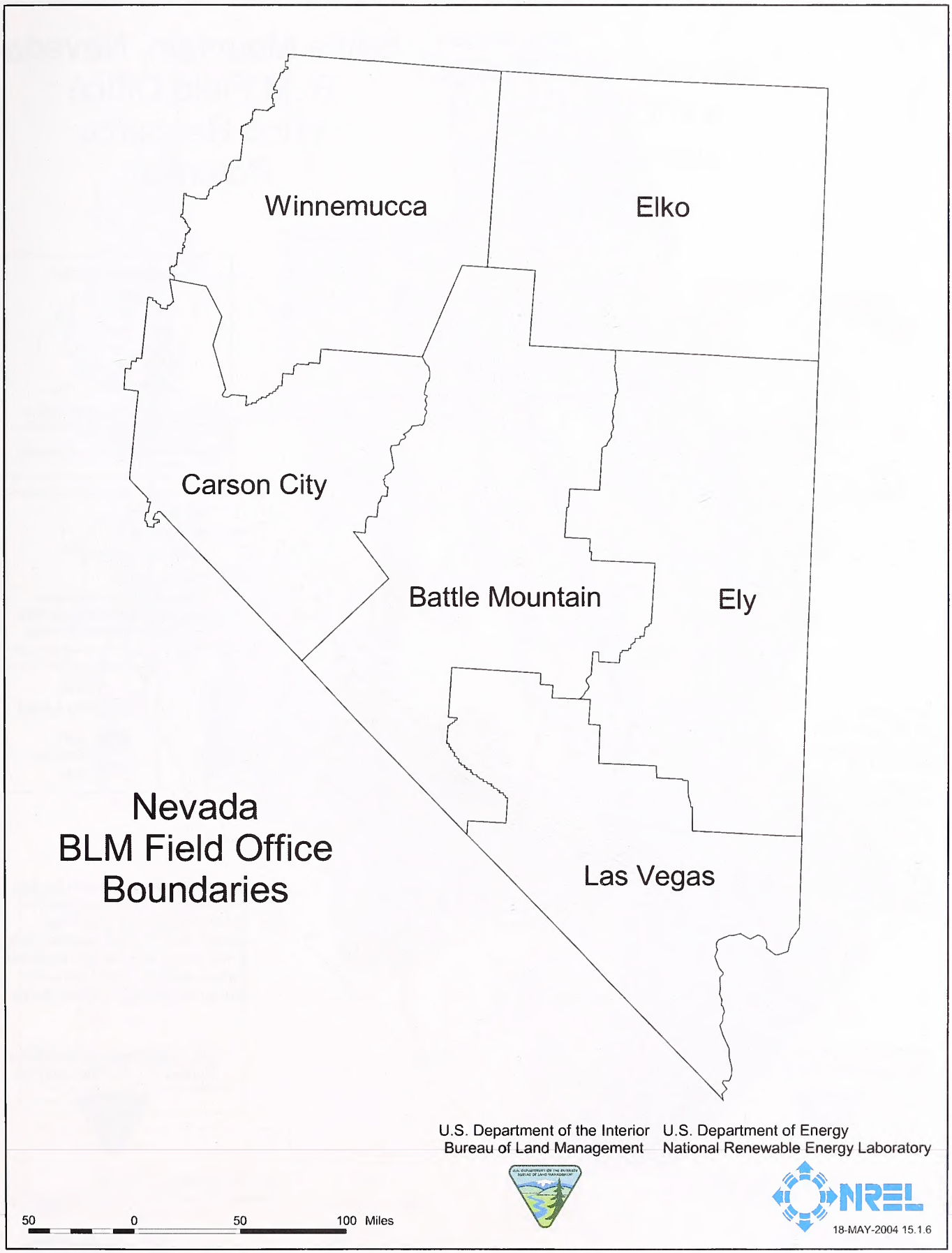
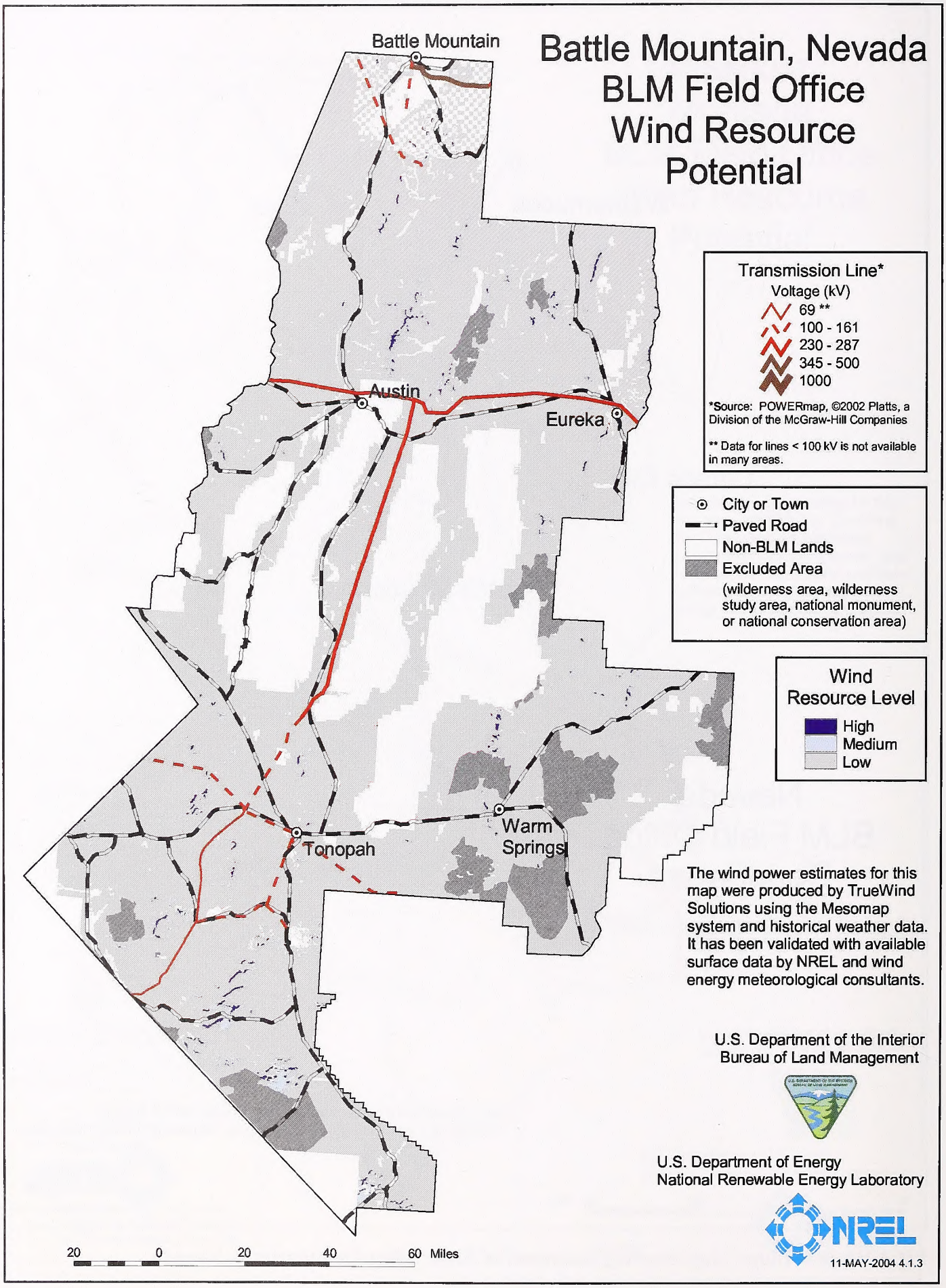


FIGURE B-8 Index Map Showing Locations of Field Office Boundaries in Nevada



Battle Mountain, Nevada BLM Field Office Wind Resource Potential

Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

** Data for lines < 100 kV is not available in many areas.

City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)

Wind Resource Level
High
Medium
Low

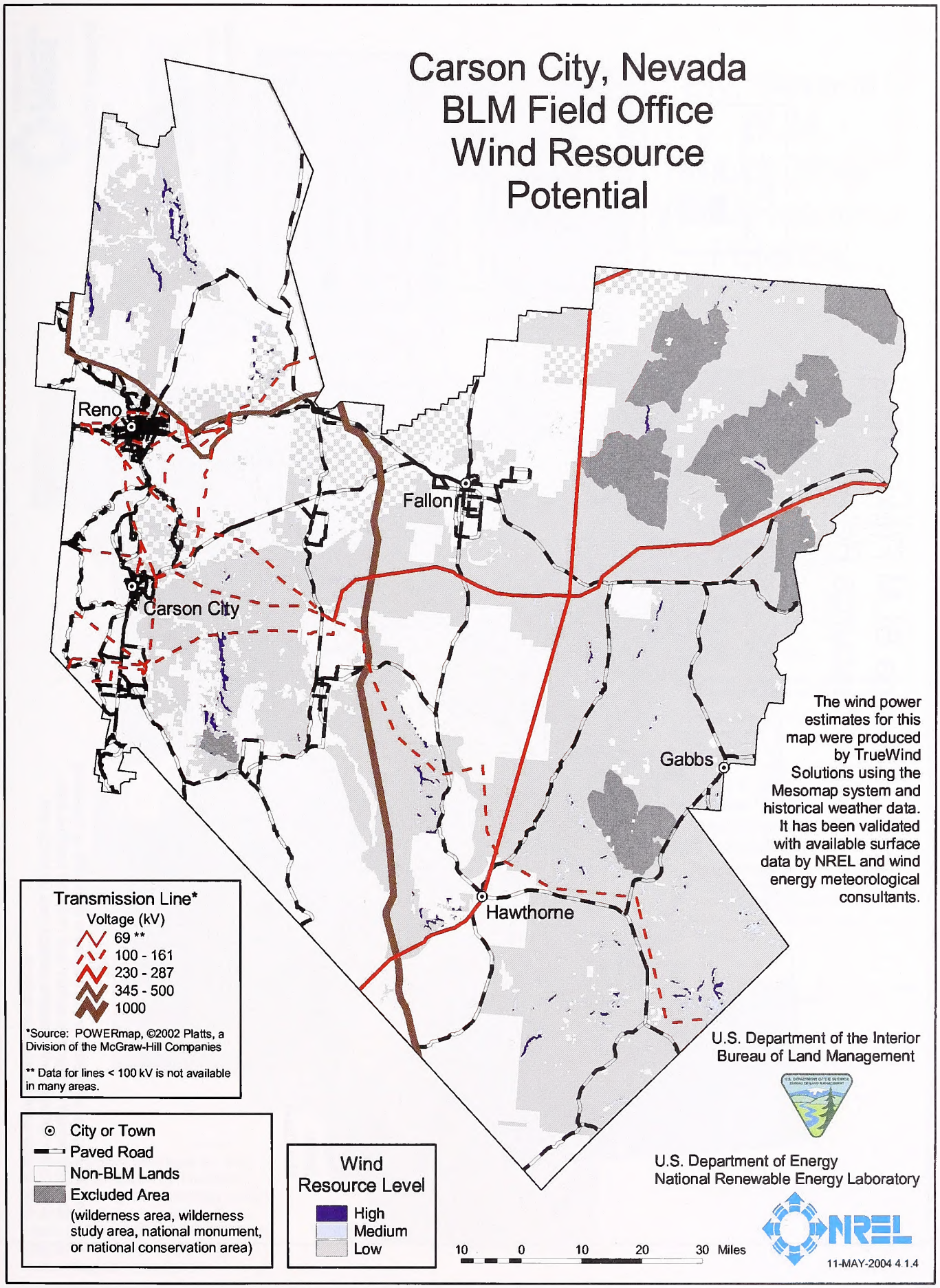
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

U.S. Department of the Interior
Bureau of Land Management

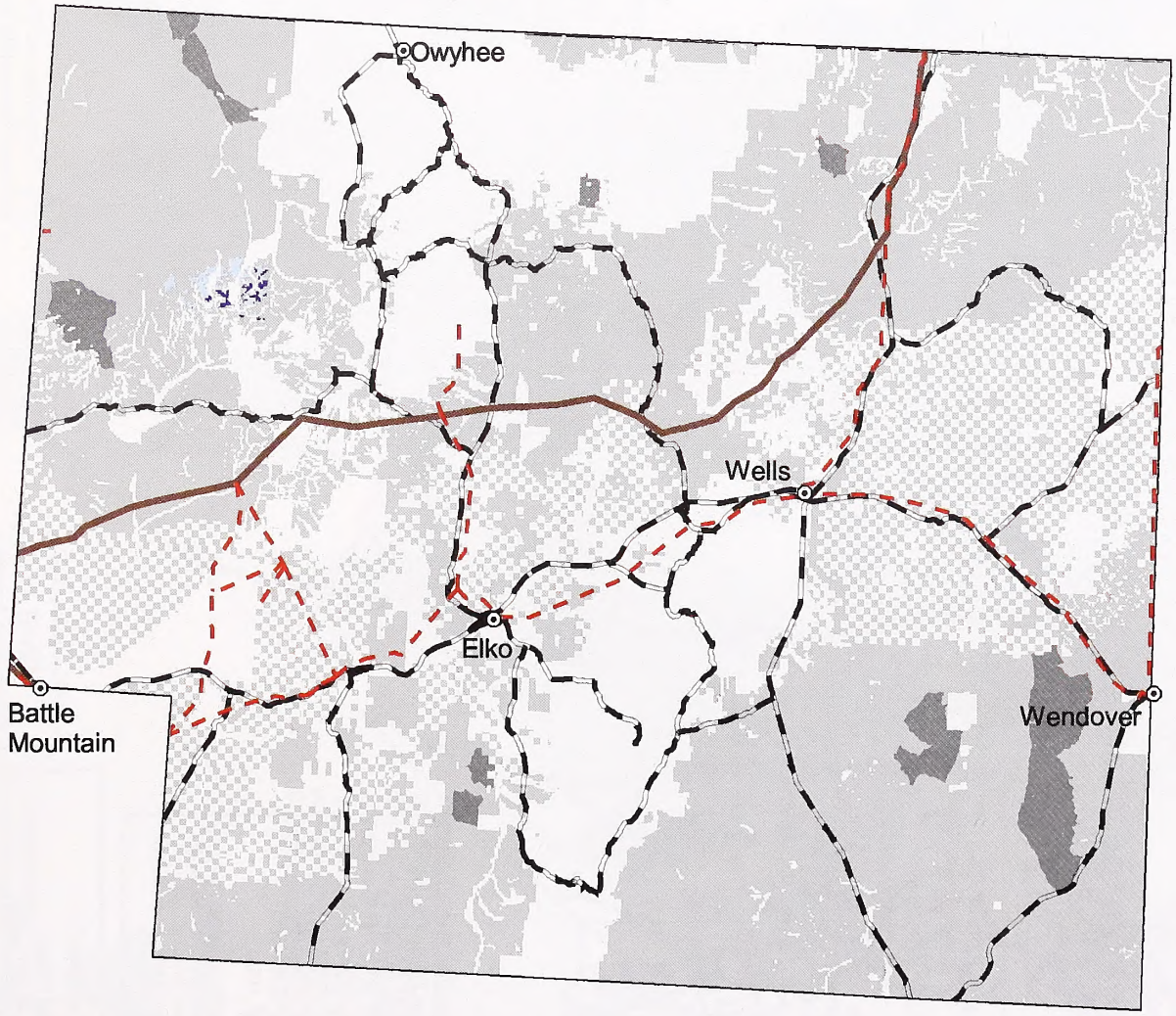
U.S. Department of Energy
National Renewable Energy Laboratory

NREL

11-MAY-2004 4.1.3


Carson City, Nevada
BLM Field Office
Wind Resource
Potential
Reno
Fallon
Carson City
Gabbs
Hawthorne
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind Resource Level
High
Medium
Low
10 0 10 20 30 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
11-MAY-2004 4.1.4

Elko, Nevada BLM Field Office
Wind Resource Potential



Wind Resource Level
- High
- Medium
- Low

Transmission Line*
Voltage (kV)
- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

** Data for lines < 100 kV is not available in many areas.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

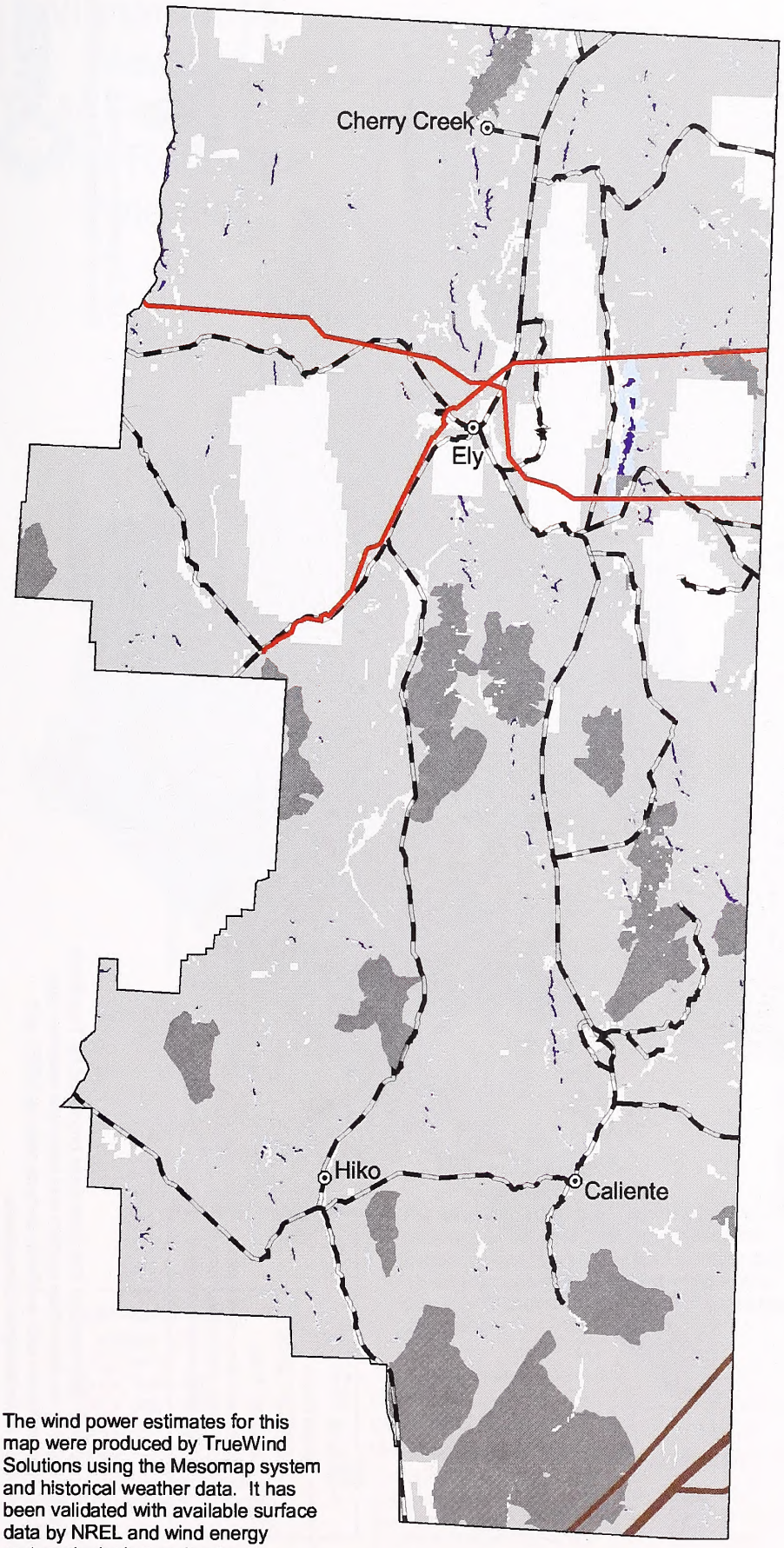
U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

11-MAY-2004 4.1.1

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.



Ely, Nevada BLM Field Office Wind Resource Potential

Wind Resource Level
- High
- Medium
- Low

Transmission Line*
Voltage (kV)
- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

** Data for lines < 100 kV is not available in many areas.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

10 0 10 20 30 Miles

U.S. Department of the Interior
Bureau of Land Management

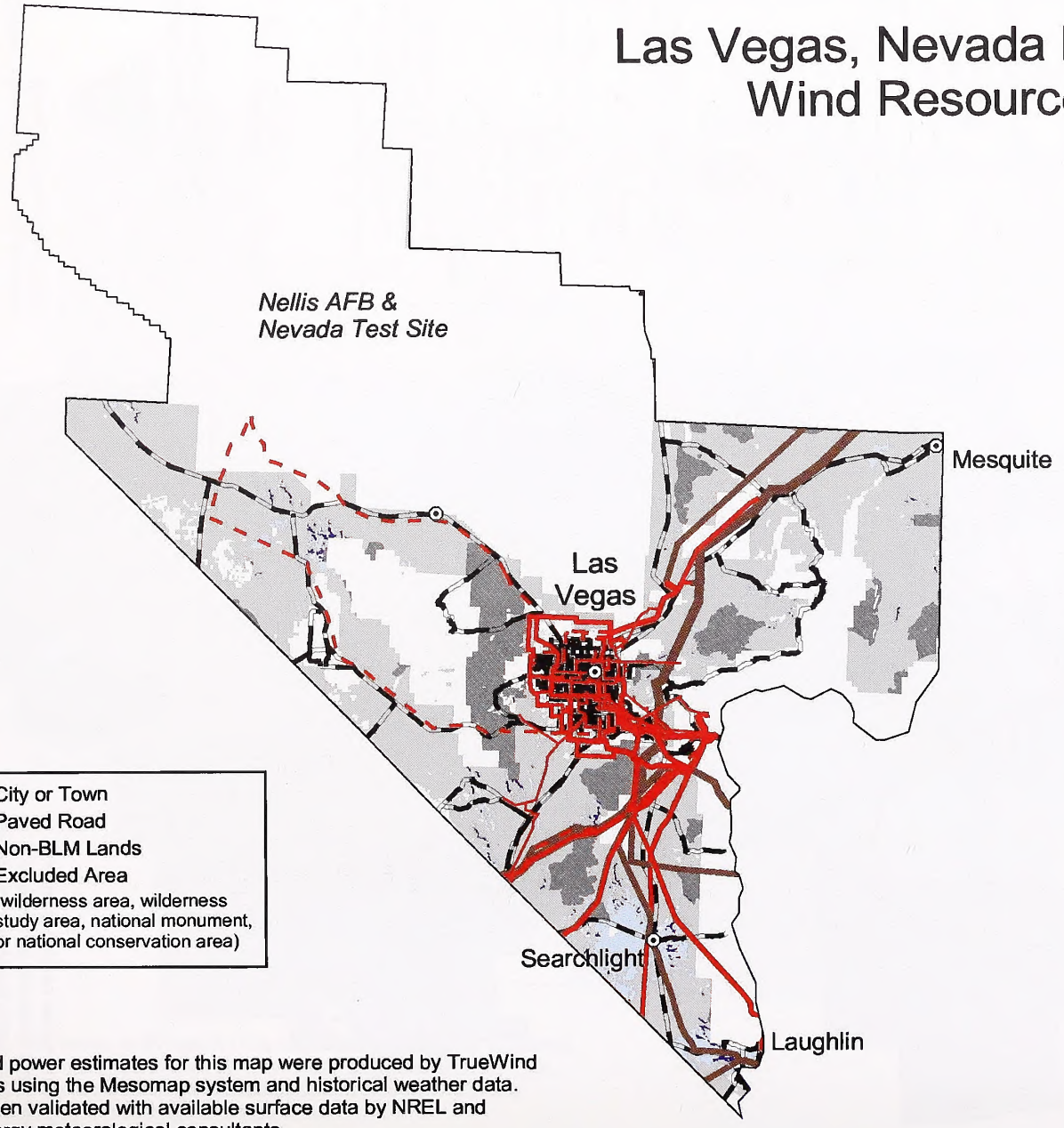
U.S. Department of Energy
National Renewable Energy Laboratory

NREL

11-MAY-2004 4.1.5

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

Las Vegas, Nevada BLM Field Office
Wind Resource Potential



Wind Resource Level
- High
- Medium
- Low

Transmission Line*
Voltage (kV)
- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

** Data for lines < 100 kV is not available in many areas.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

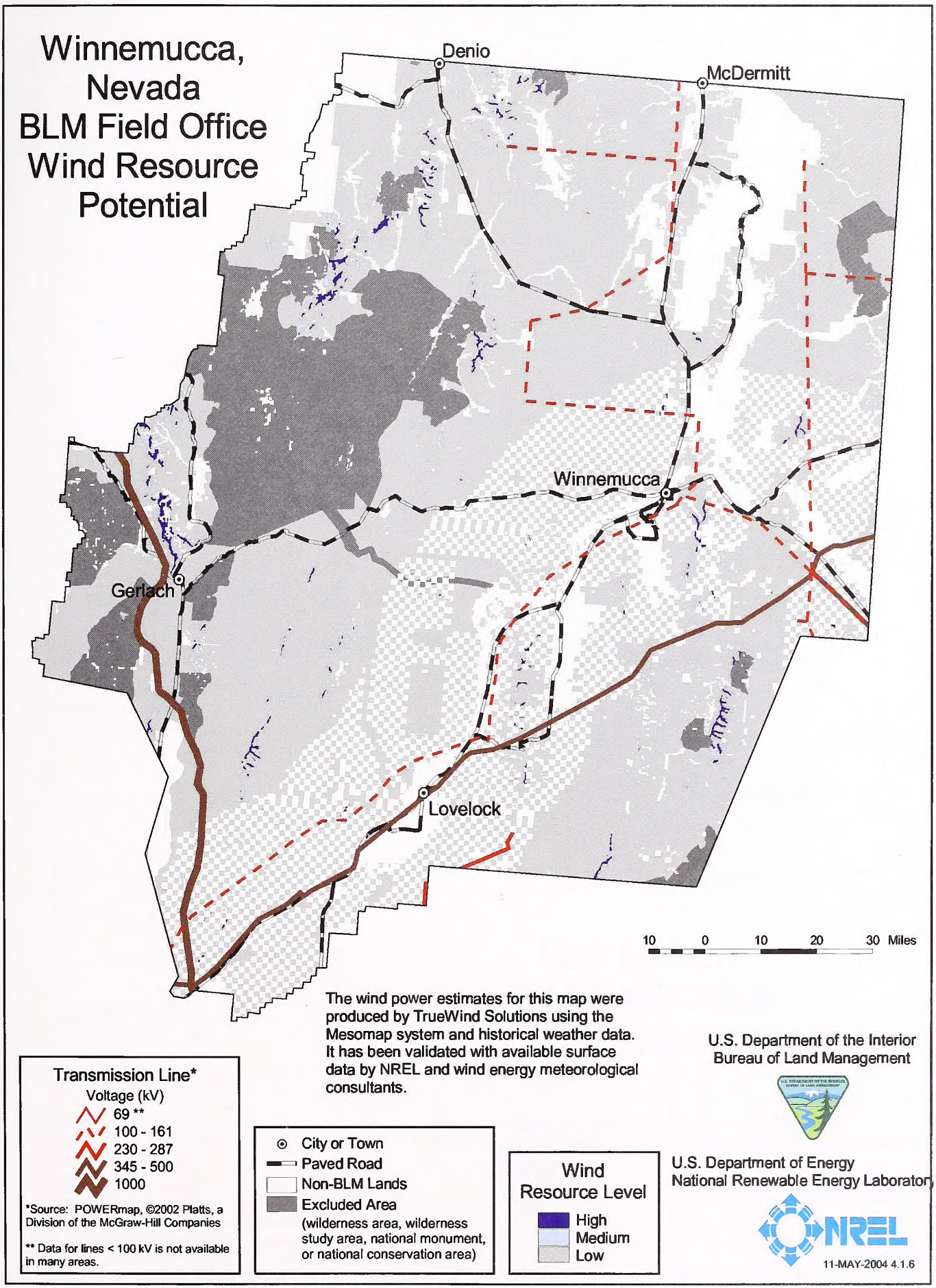
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

15-JUN-2004 4.1.2


Winnemucca, Nevada BLM Field Office Wind Resource Potential
Denio
McDermitt
Winnemucca
Gerlach
Lovelock
10 0 10 20 30 Miles
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
U.S. Department of the Interior
Bureau of Land Management
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind Resource Level
High
Medium
Low
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
11-MAY-2004 4.1.6

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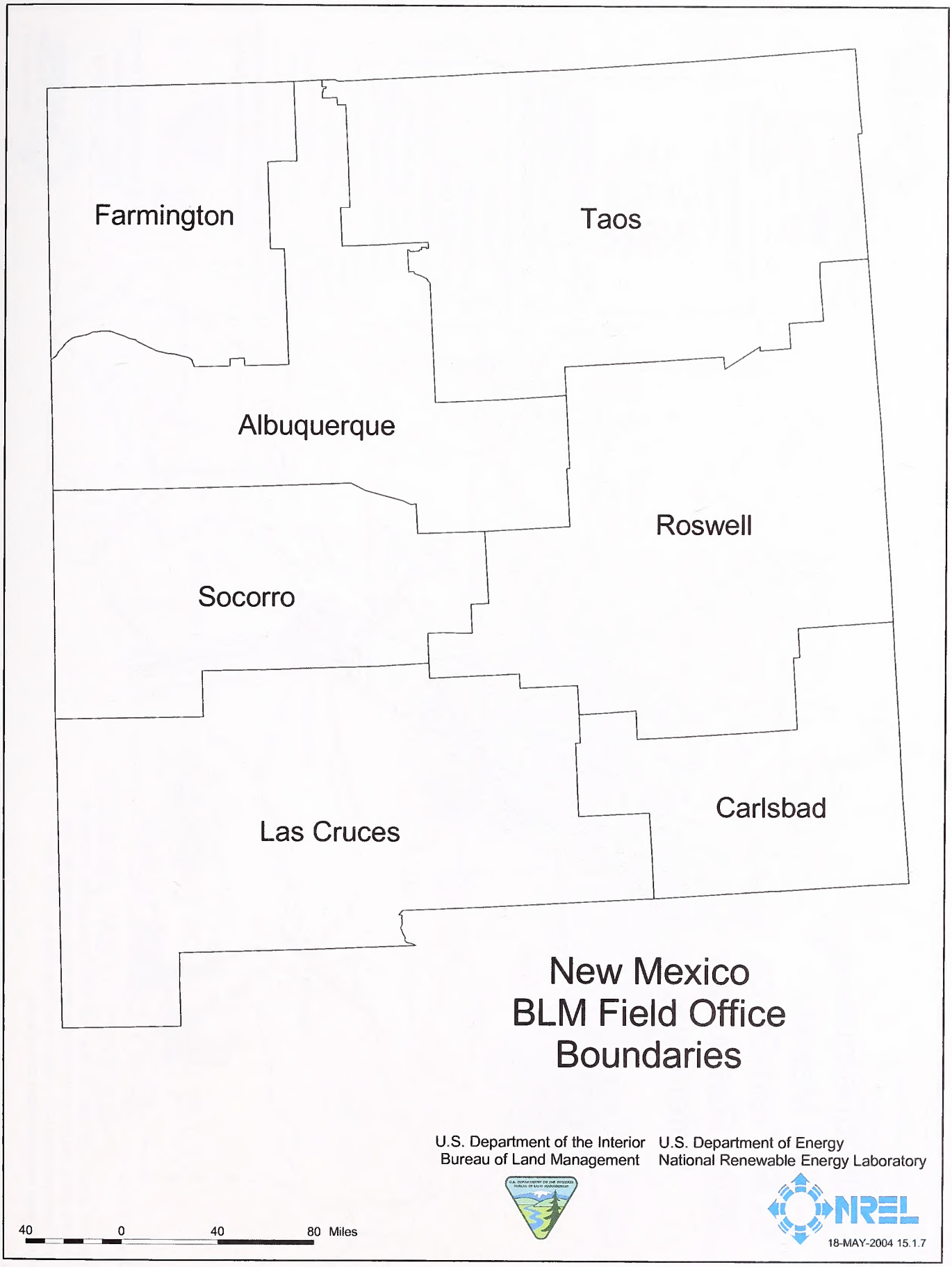
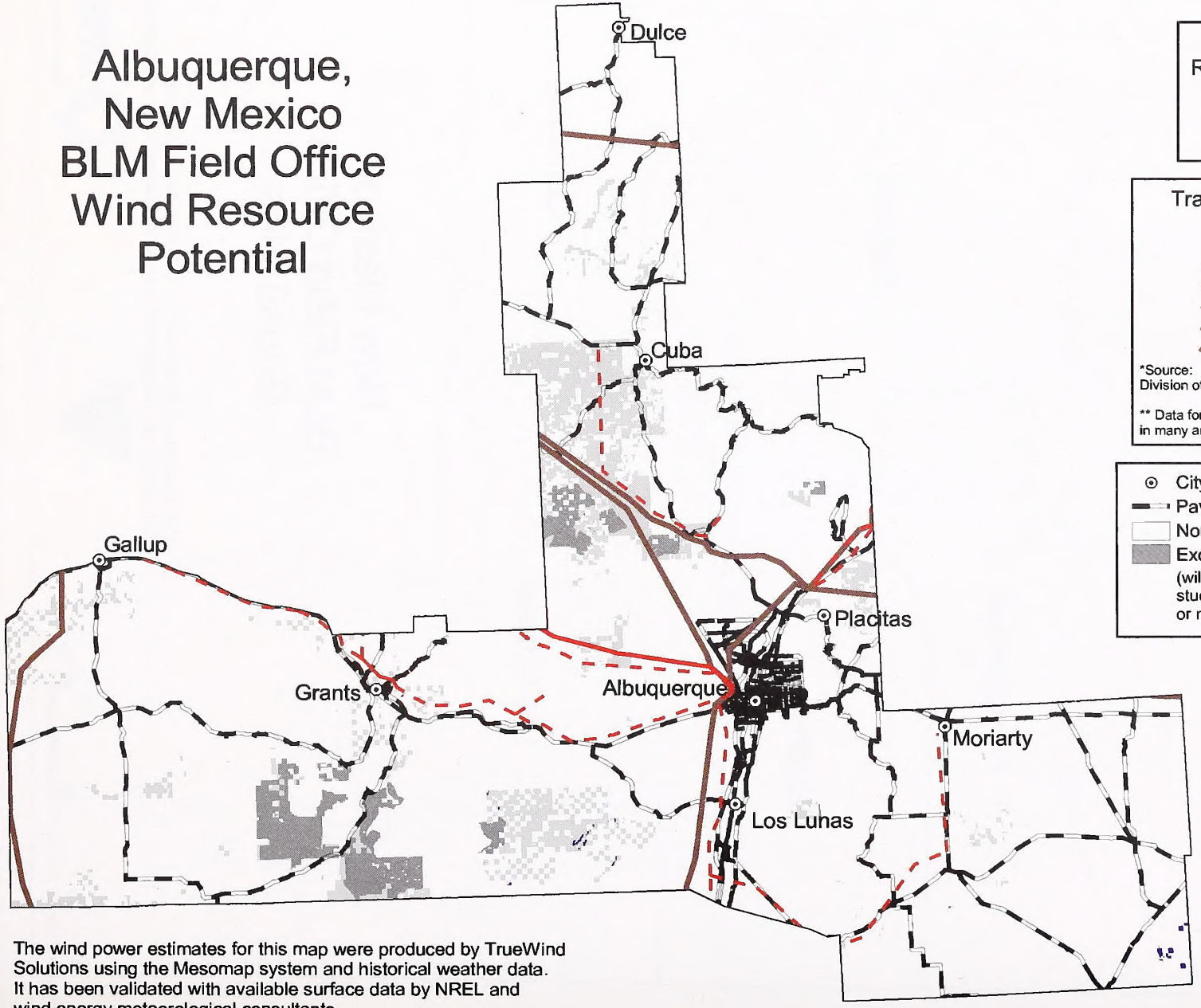


FIGURE B-9 Index Map Showing Locations of Field Office Boundaries in New Mexico

Albuquerque, New Mexico BLM Field Office Wind Resource Potential



Wind Resource Level
- High
- Medium
- Low

Transmission Line*
Voltage (kV)
- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

** Data for lines < 100 kV is not available in many areas.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

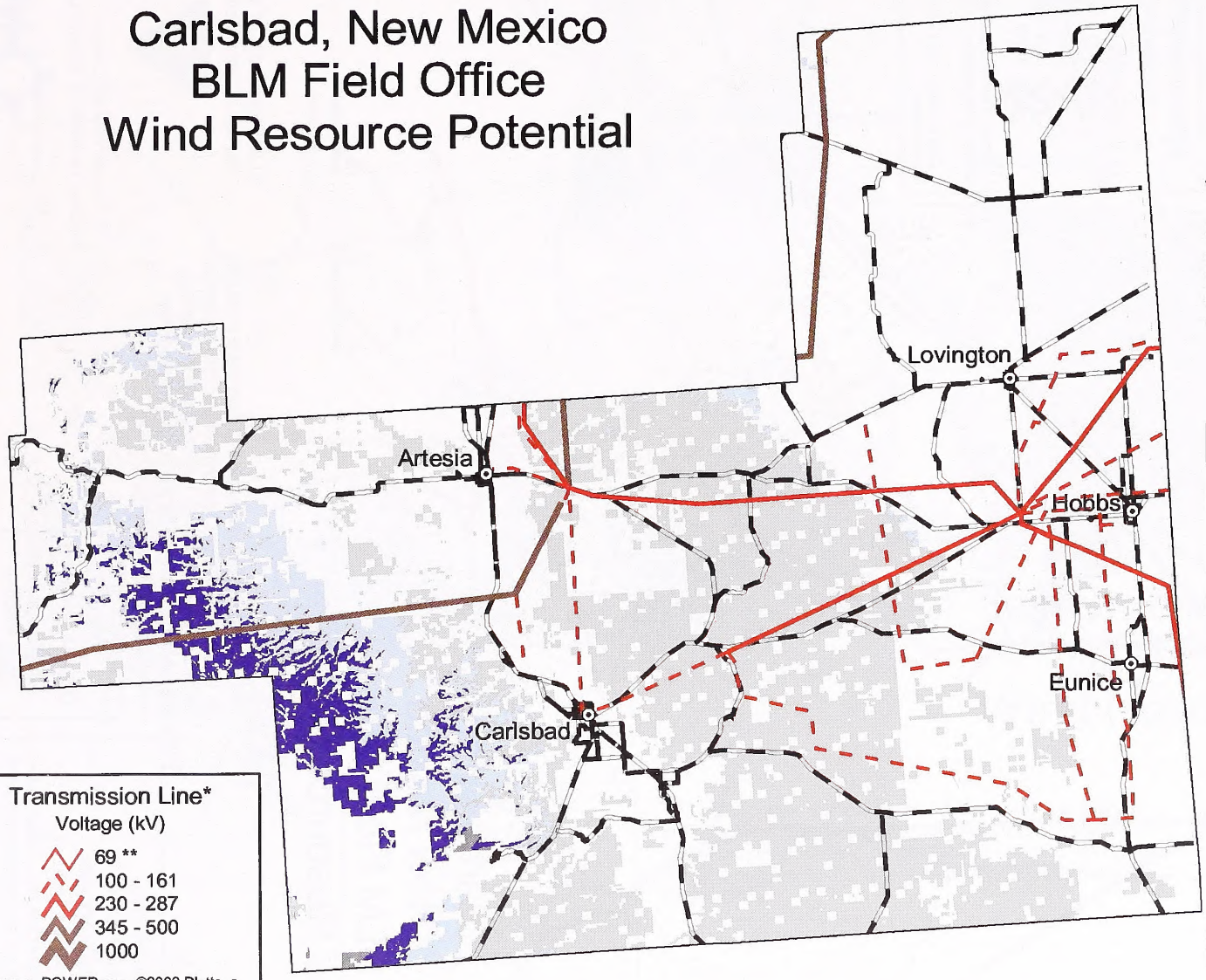
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory
NREL

19-JUL-2004 7.1.1

Carlsbad, New Mexico
BLM Field Office
Wind Resource Potential



Wind Resource Level

- High
- Medium
- Low

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

Transmission Line*
Voltage (kV)

- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

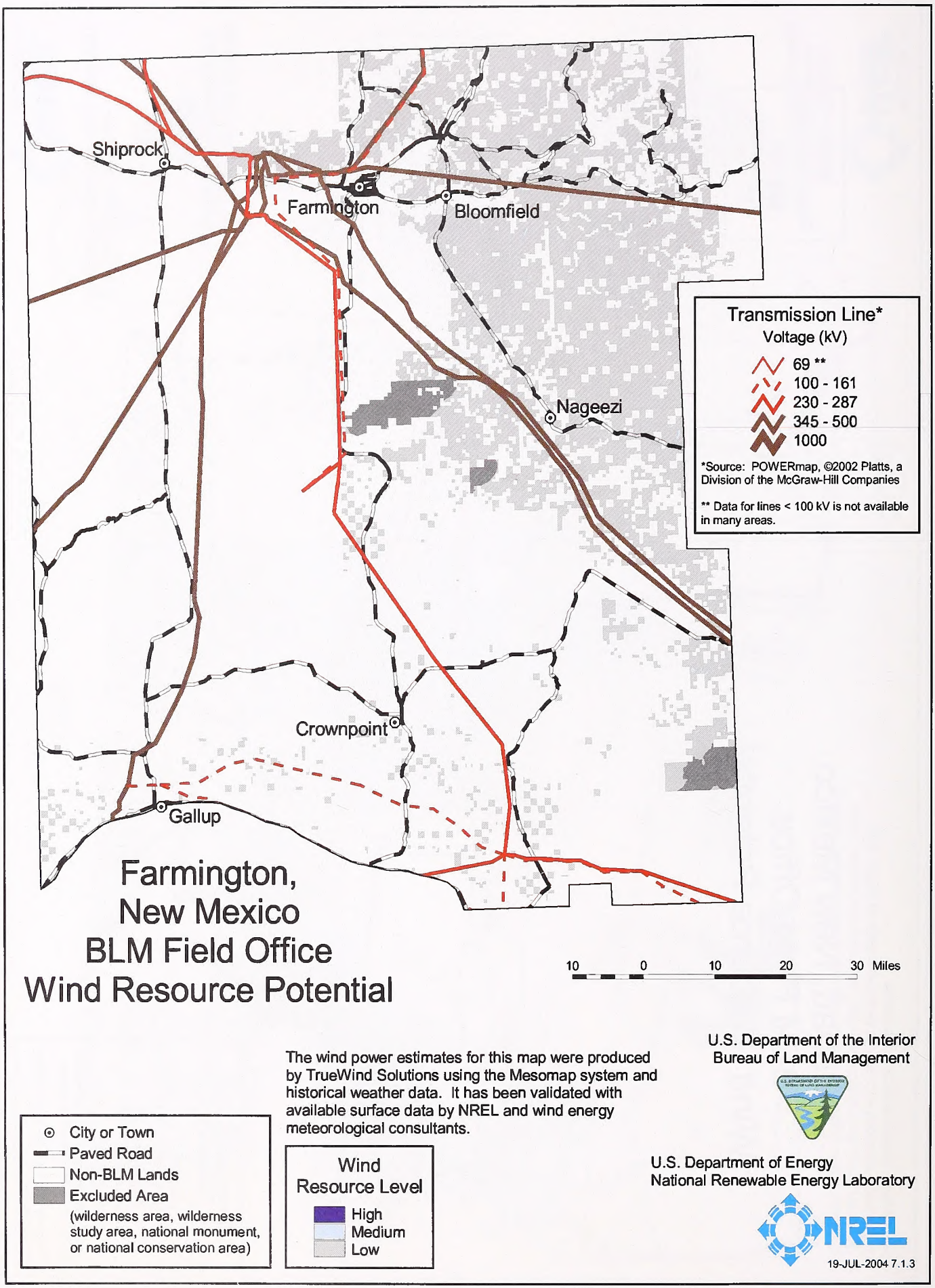
** Data for lines < 100 kV is not available in many areas.

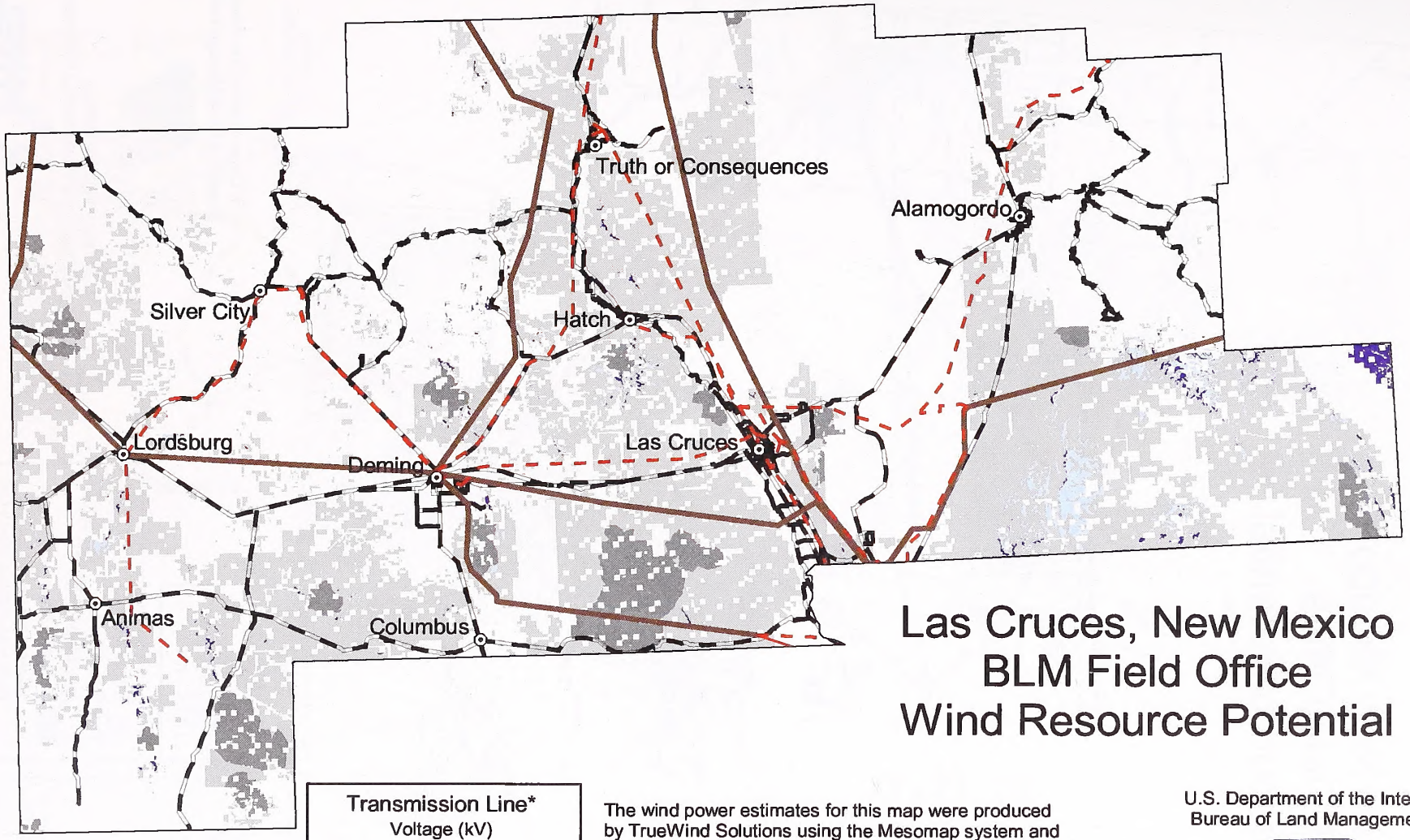
U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

19-JUL-2004 7.1.2


Shiprock
Farmington
Bloomfield
Nageezi
Crownpoint
Gallup
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
10 0 10 20 30 Miles
Farmington, New Mexico BLM Field Office Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind Resource Level
High
Medium
Low
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
19-JUL-2004 7.1.3



Las Cruces, New Mexico BLM Field Office Wind Resource Potential

City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)

Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

** Data for lines < 100 kV is not available in many areas.

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

Wind Resource Level
High
Medium
Low

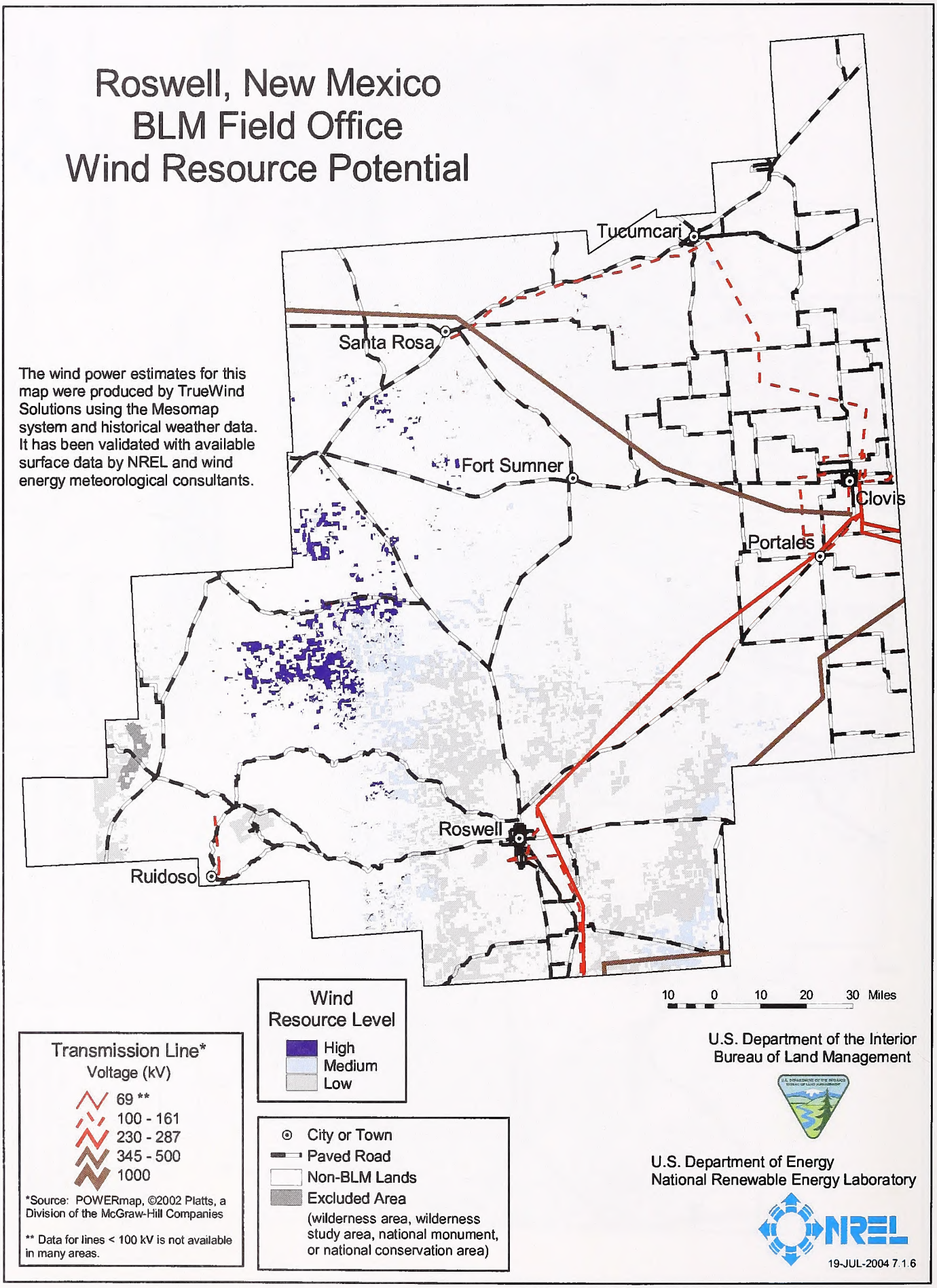
10 0 10 20 30 Miles

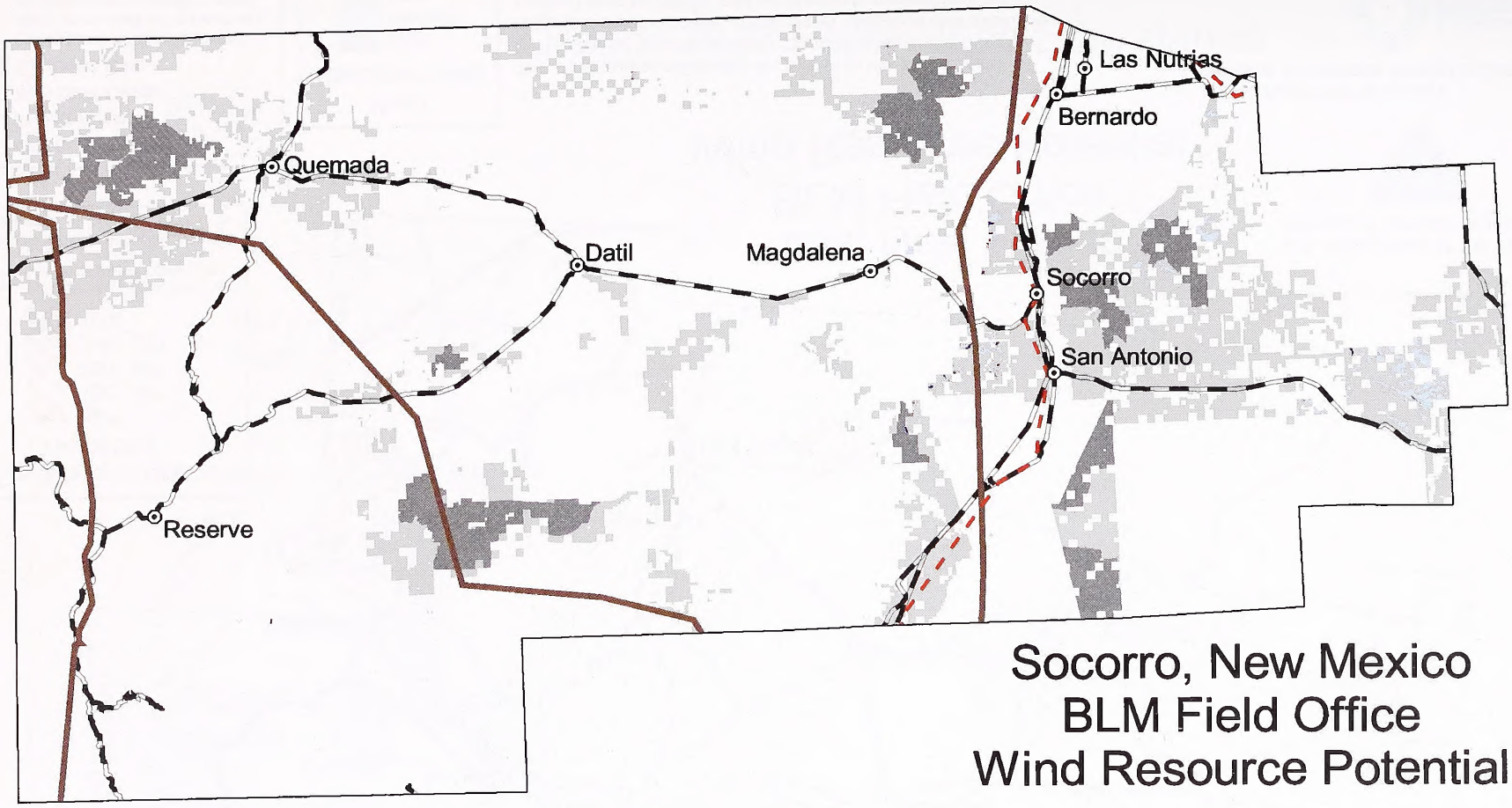
U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

19-JUL-2004 7.1.4


Roswell, New Mexico
BLM Field Office
Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Tucumcari
Santa Rosa
Fort Sumner
Clovis
Portales
Roswell
Ruidoso
10 0 10 20 30 Miles
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
19-JUL-2004 7.1.6



Socorro, New Mexico
BLM Field Office
Wind Resource Potential

City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)

Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies

** Data for lines < 100 kV is not available in many areas.

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

Wind Resource Level
High
Medium
Low

10 0 10 20 Miles

U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory
NREL

19-JUL-2004 7.1.5

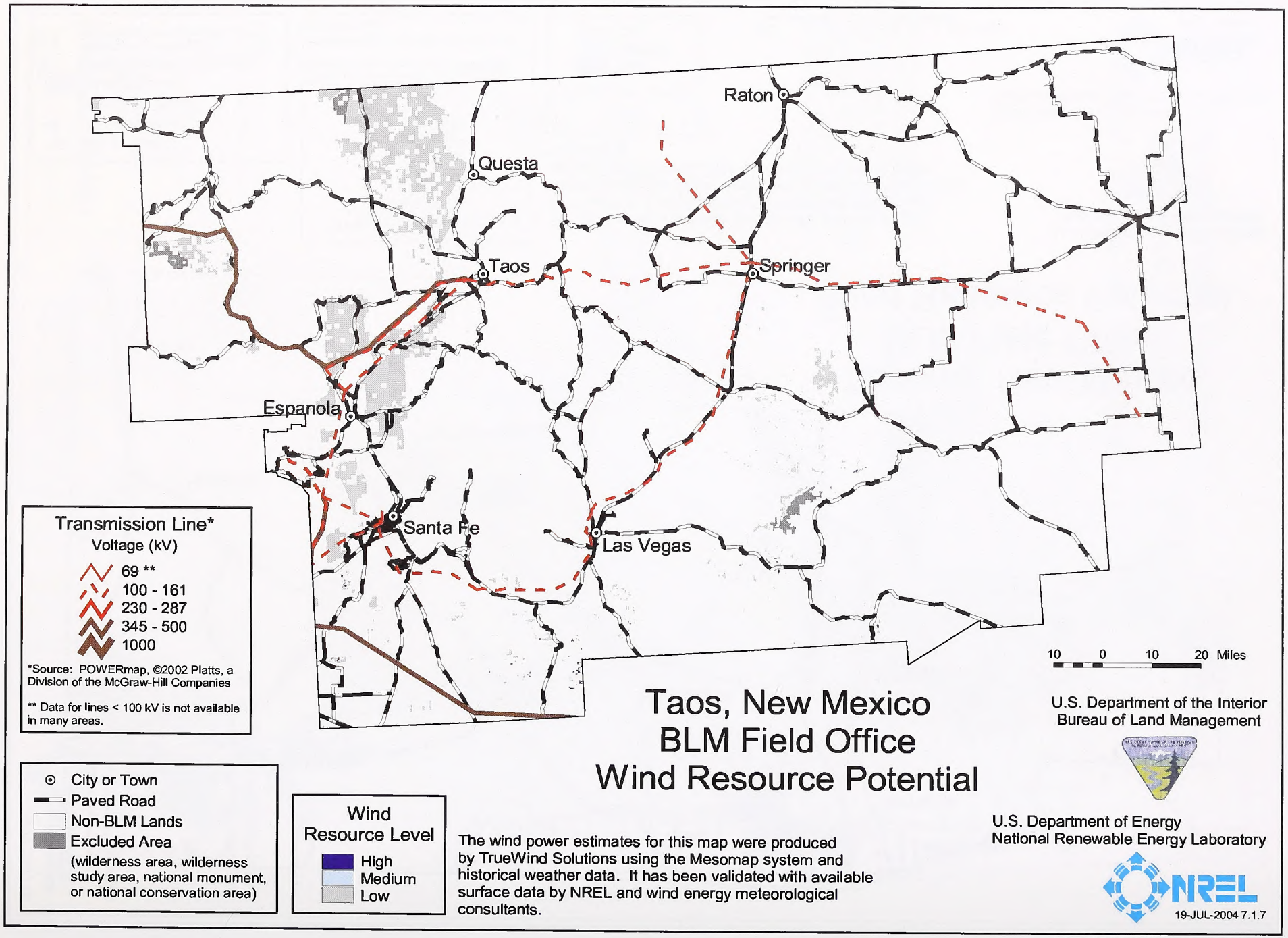
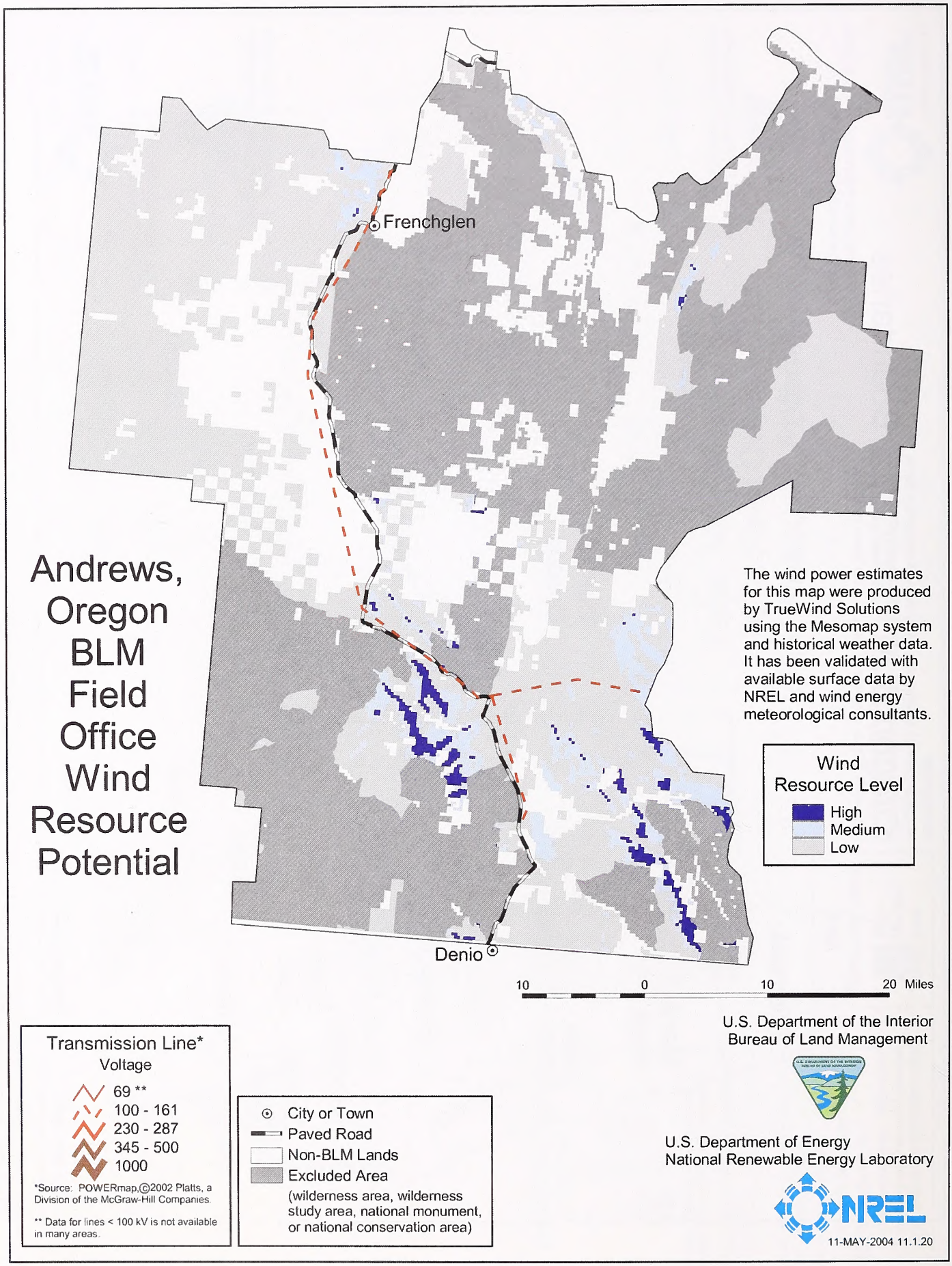
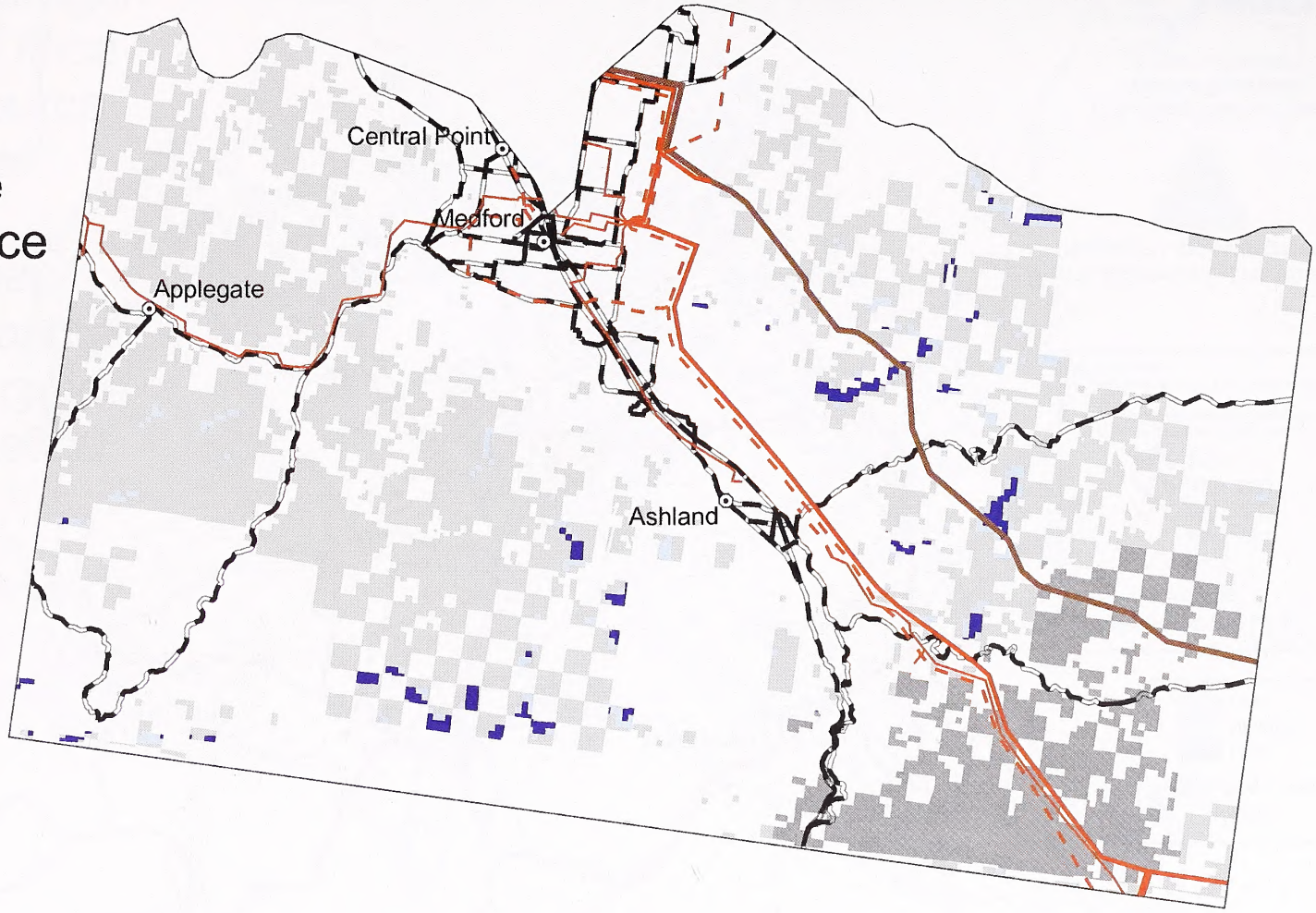

Raton
Questa
Taos
Springer
Espanola
Santa Fe
Las Vegas
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies
** Data for lines < 100 kV is not available in many areas.
10 0 10 20 Miles
Taos, New Mexico
BLM Field Office
Wind Resource Potential
U.S. Department of the Interior
Bureau of Land Management
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
19-JUL-2004 7.1.7



FIGURE B-10 Index Map Showing Locations of Field Office Boundaries in Oregon


Frenchglen
Denio
Andrews, Oregon BLM Field Office Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
10 0 10 20 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
11-MAY-2004 11.1.20
Transmission Line*
Voltage
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap,©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)

Ashland, Oregon BLM Field Office Wind Resource Potential



The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

Transmission Line*
Voltage

- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap© 2002 Platts, a Division of the McGraw-Hill Companies.

** Data for lines < 100 kV is not available in many areas.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

Wind Resource Level

- High
- Medium
- Low

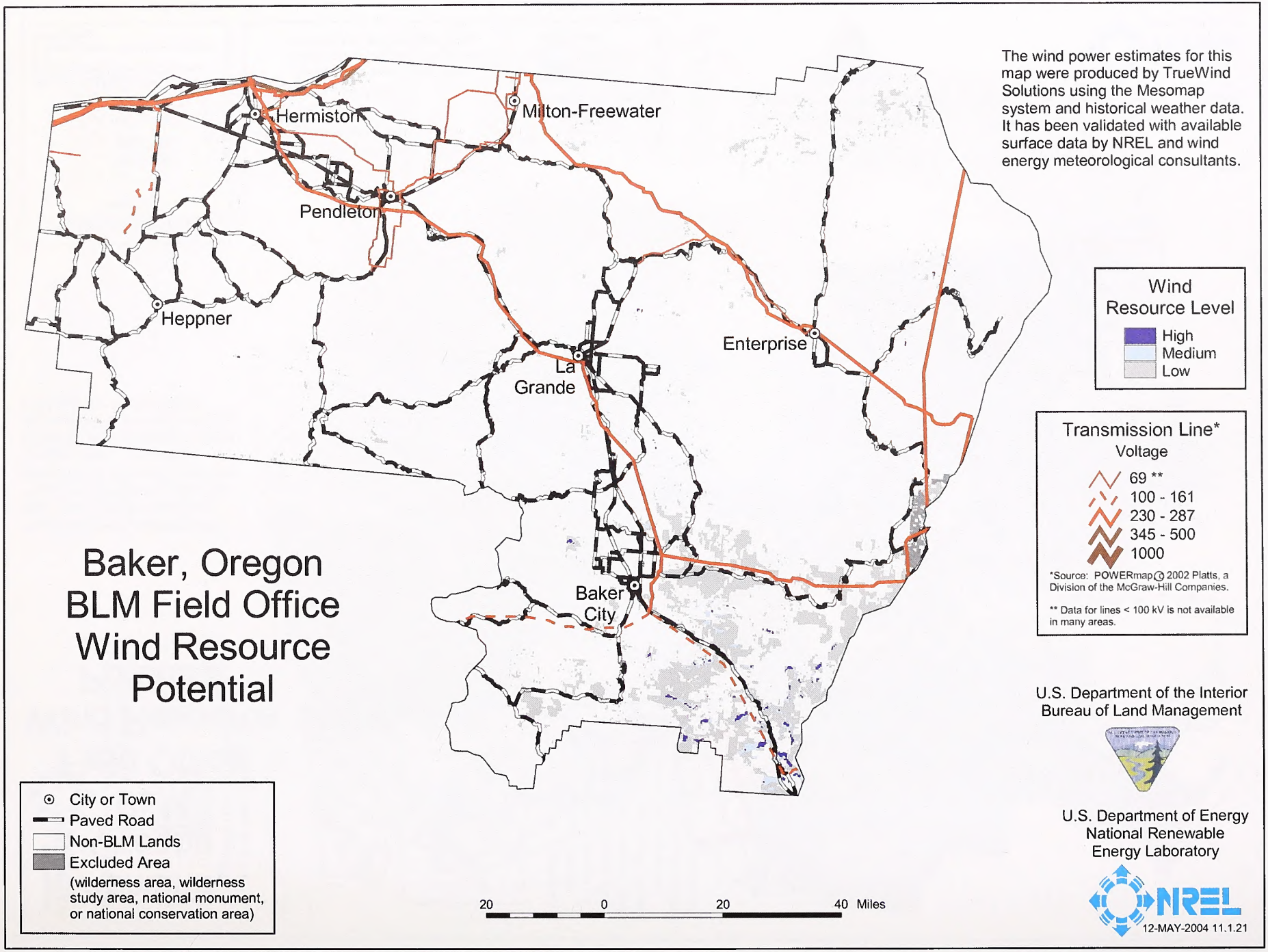
5 0 5 10 15 Miles

U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory

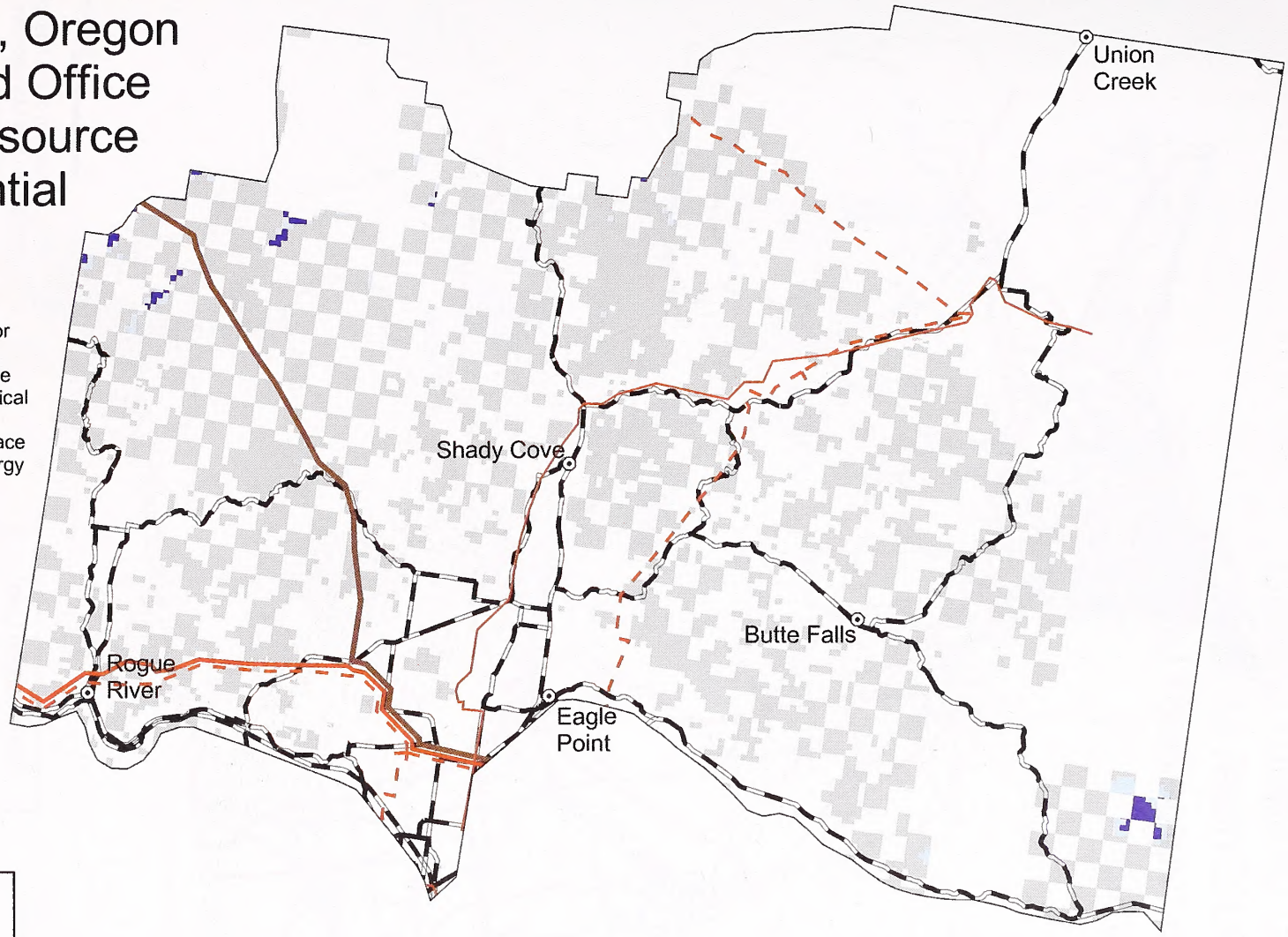
NREL

12-MAY-2004 11.1.14


The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Hermiston
Milton-Freewater
Pendleton
Heppner
La Grande
Enterprise
Baker City
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap© 2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
Baker, Oregon
BLM Field Office
Wind Resource
Potential
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
20 0 20 40 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
12-MAY-2004 11.1.21

Butte Falls, Oregon BLM Field Office Wind Resource Potential

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.



Transmission Line*
Voltage
- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.

** Data for lines < 100 kV is not available in many areas.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

Wind Resource Level
- High
- Medium
- Low

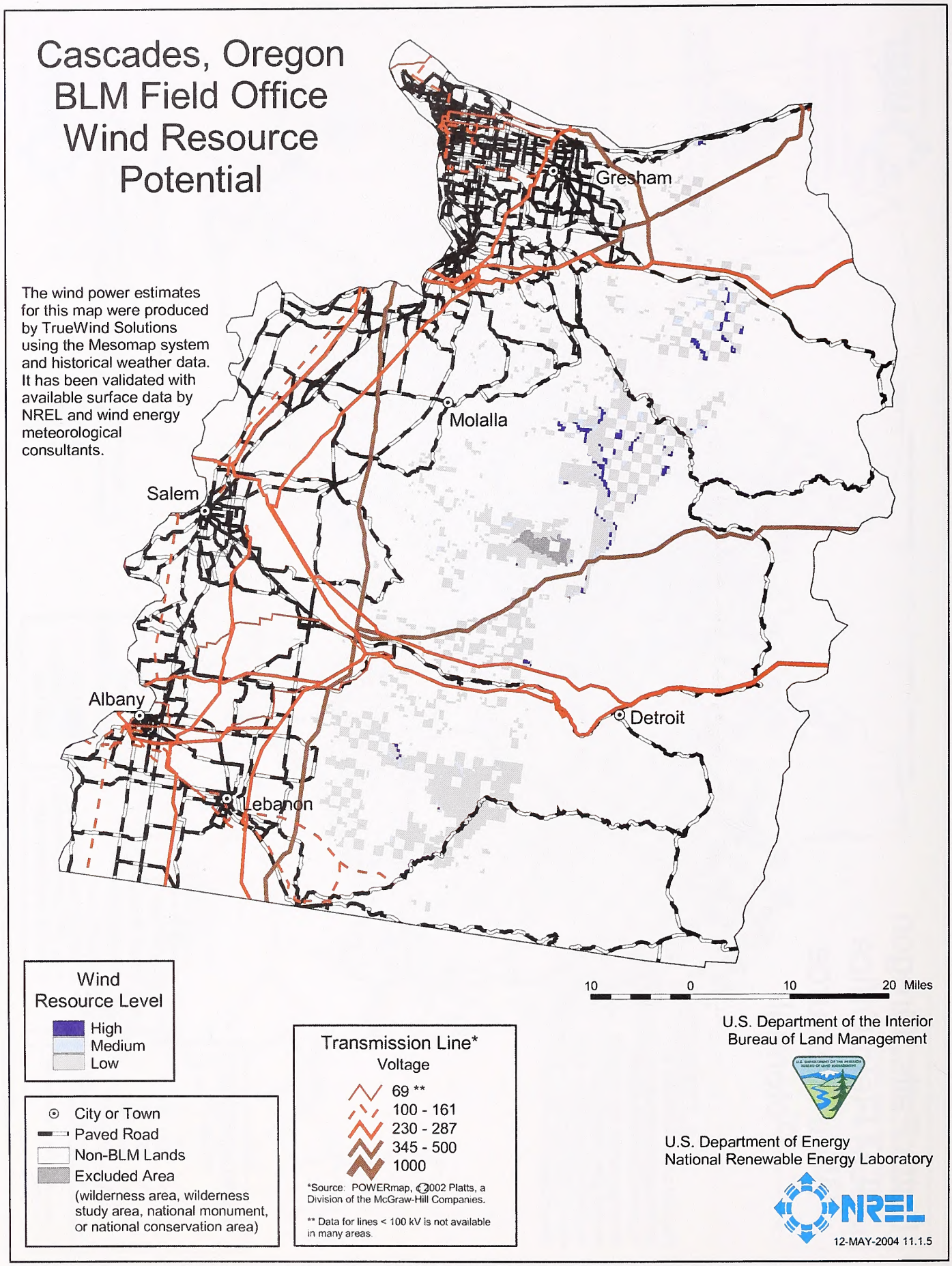
5 0 5 10 15 Miles

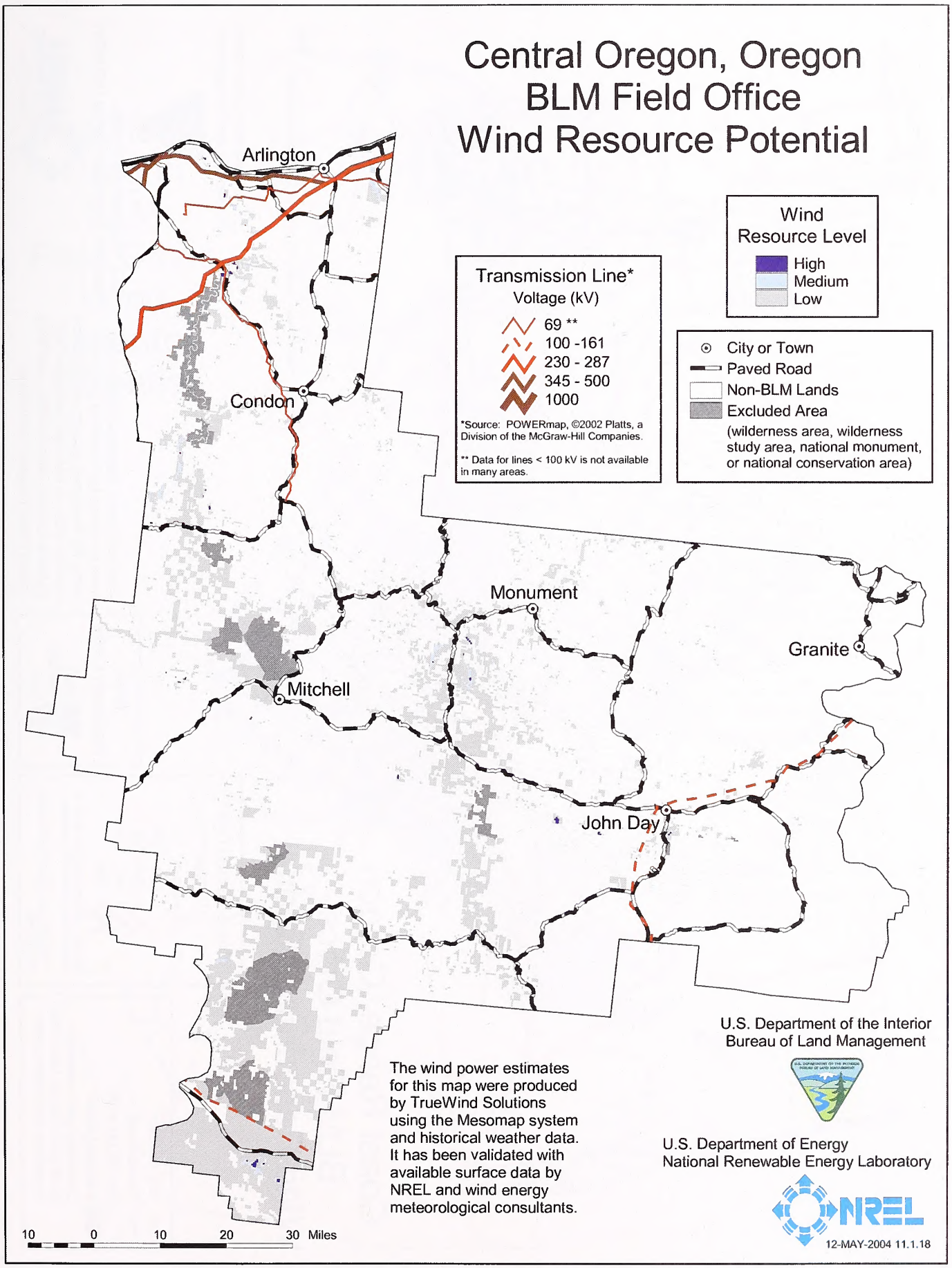
U.S. Department of the Interior
Bureau of Land Management

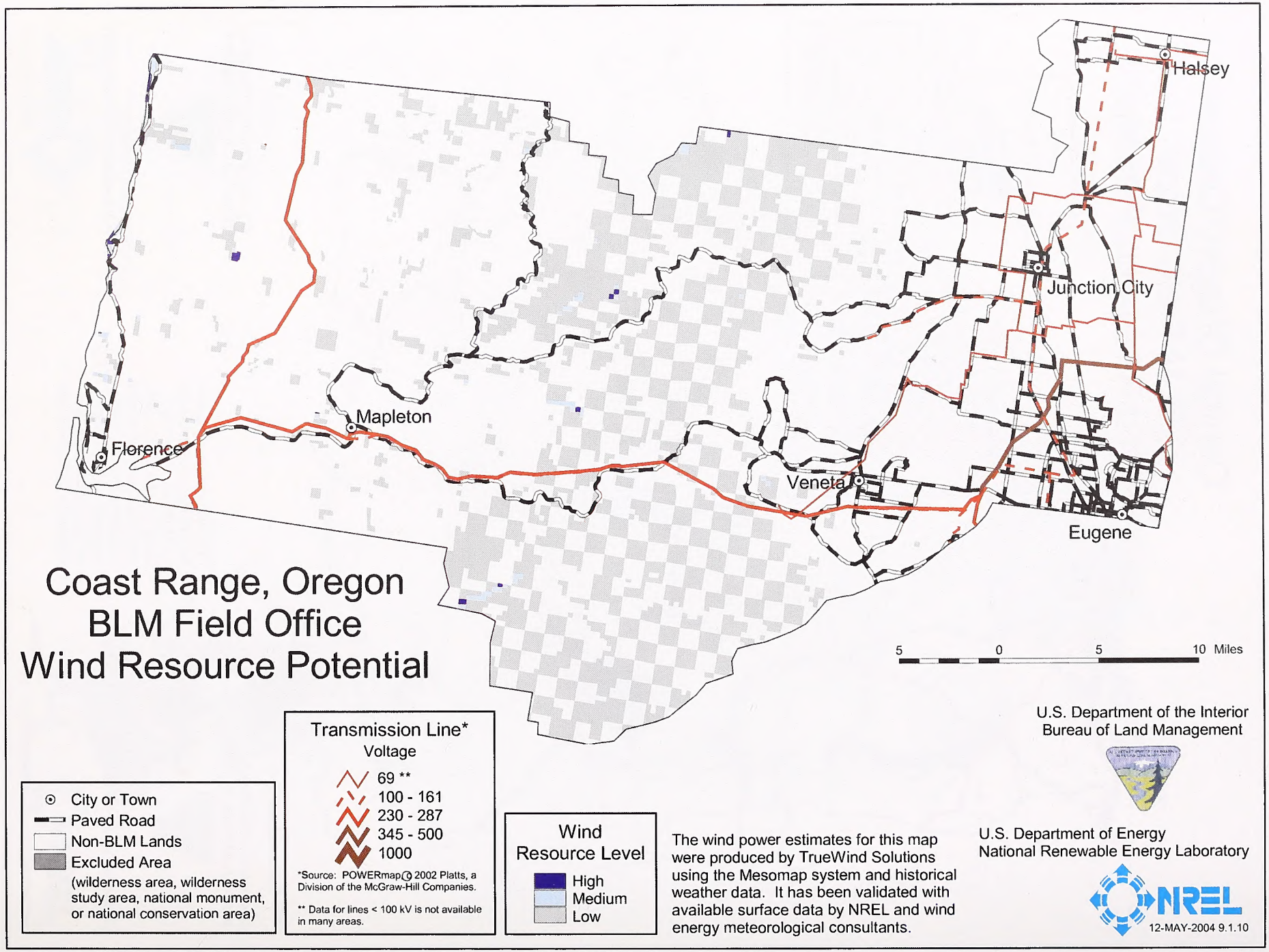
U.S. Department of Energy
National Renewable Energy Laboratory

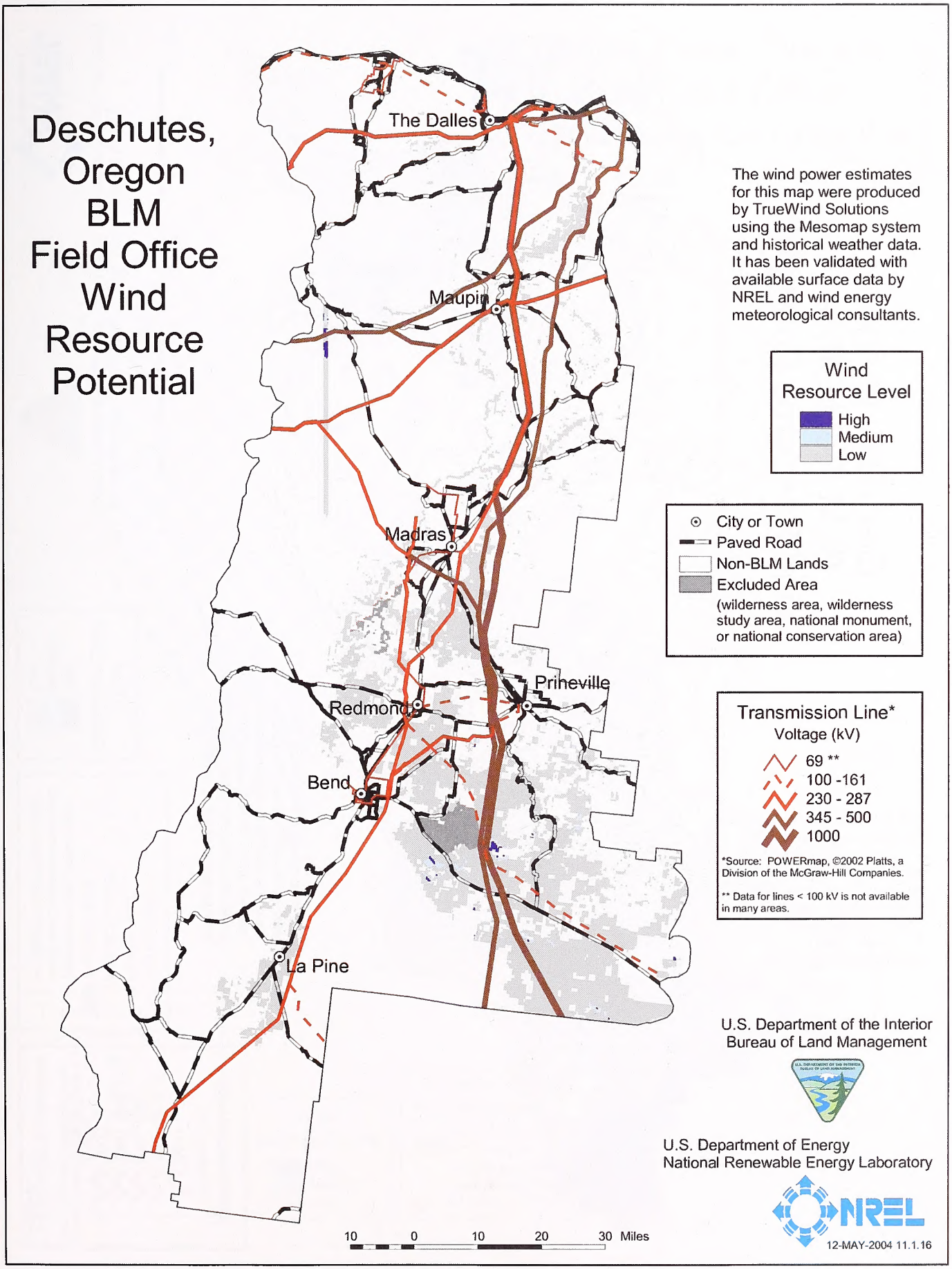
NREL

12-MAY-2004 11.1.13

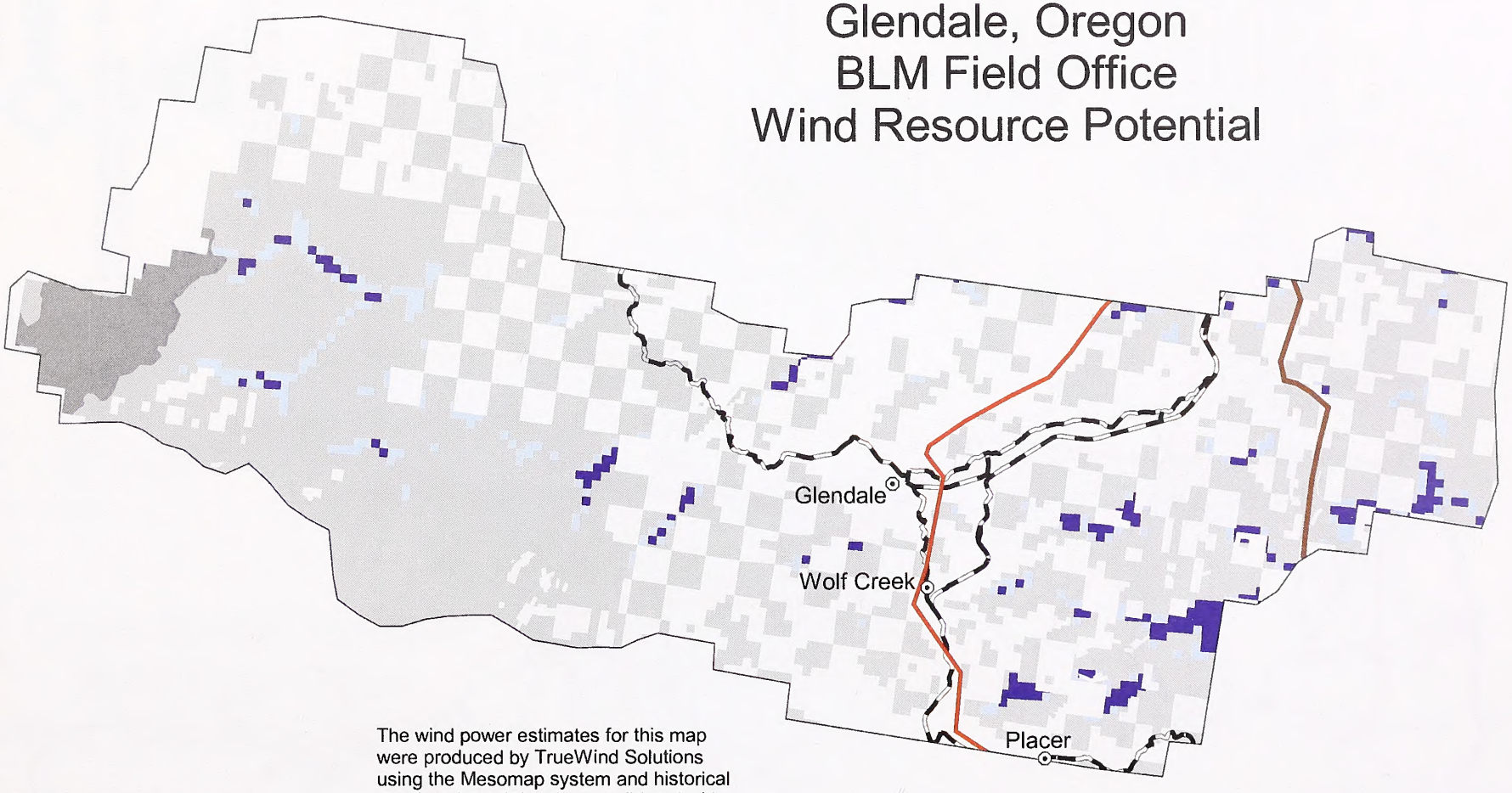

Cascades, Oregon
BLM Field Office
Wind Resource
Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Gresham
Molalla
Salem
Albany
Lebanon
Detroit
Wind Resource Level
High
Medium
Low
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Transmission Line*
Voltage
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
10 0 10 20 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 11.1.5


Central Oregon, Oregon
BLM Field Office
Wind Resource Potential
Arlington
Condon
Monument
Granite
Mitchell
John Day
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 -161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
10 0 10 20 30 Miles
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 11.1.18


Halsey
Junction City
Mapleton
Florence
Veneta
Eugene
Coast Range, Oregon
BLM Field Office
Wind Resource Potential
5 0 5 10 Miles
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Transmission Line*
Voltage
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap© 2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
Wind Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 9.1.10


Deschutes, Oregon BLM Field Office Wind Resource Potential
The Dalles
Maupin
Madras
Prineville
Redmond
Bend
La Pine
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Transmission Line*
Voltage (kV)
69 **
100 -161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
10 0 10 20 30 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 11.1.16

Glendale, Oregon
BLM Field Office
Wind Resource Potential



The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

Transmission Line*
Voltage (kV)

- 69 **
- 100 -161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.

** Data for lines < 100 kV is not available in many areas.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

Wind Resource Level

- High
- Medium
- Low

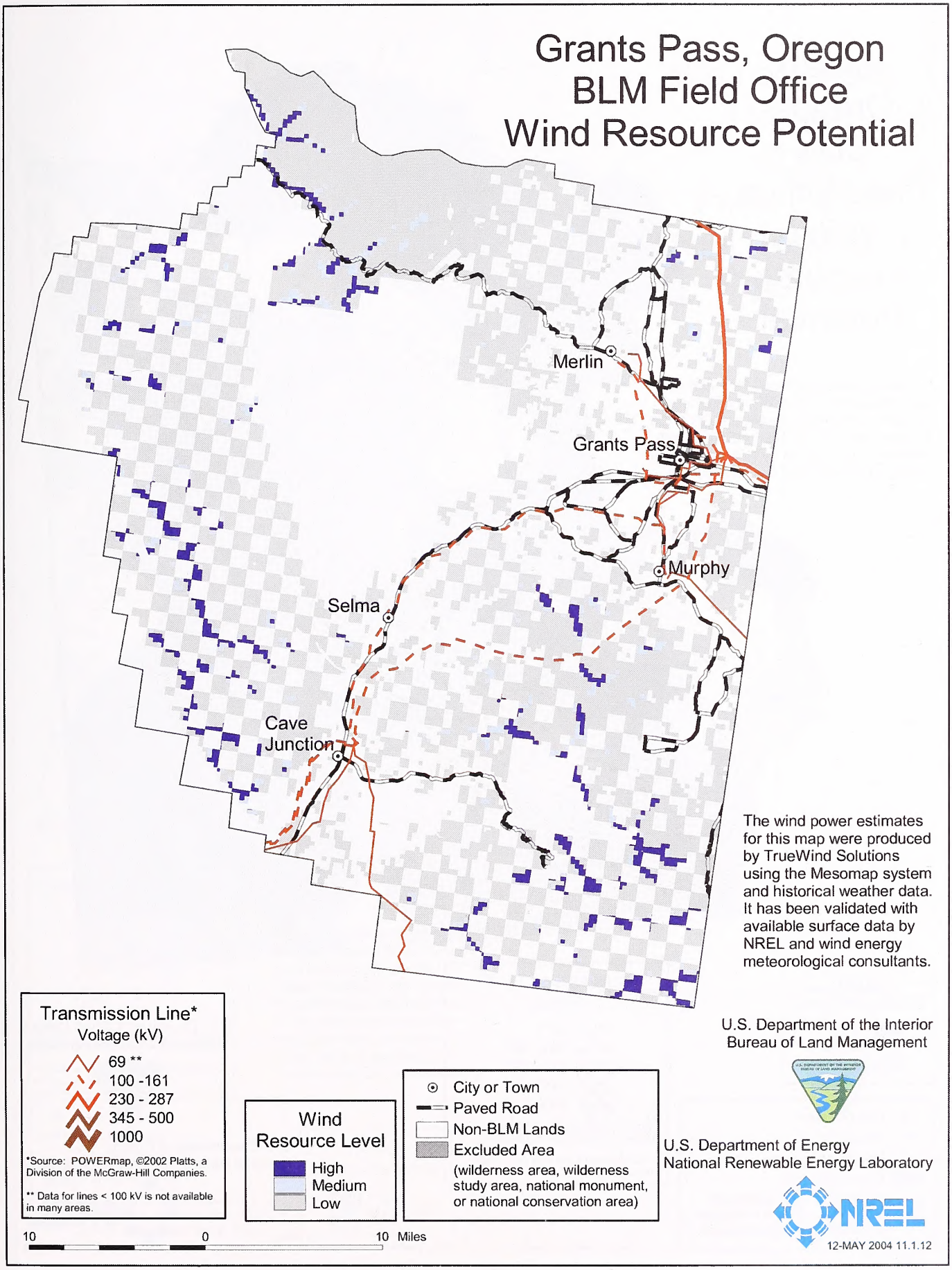
5 0 5 10 Miles

U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory

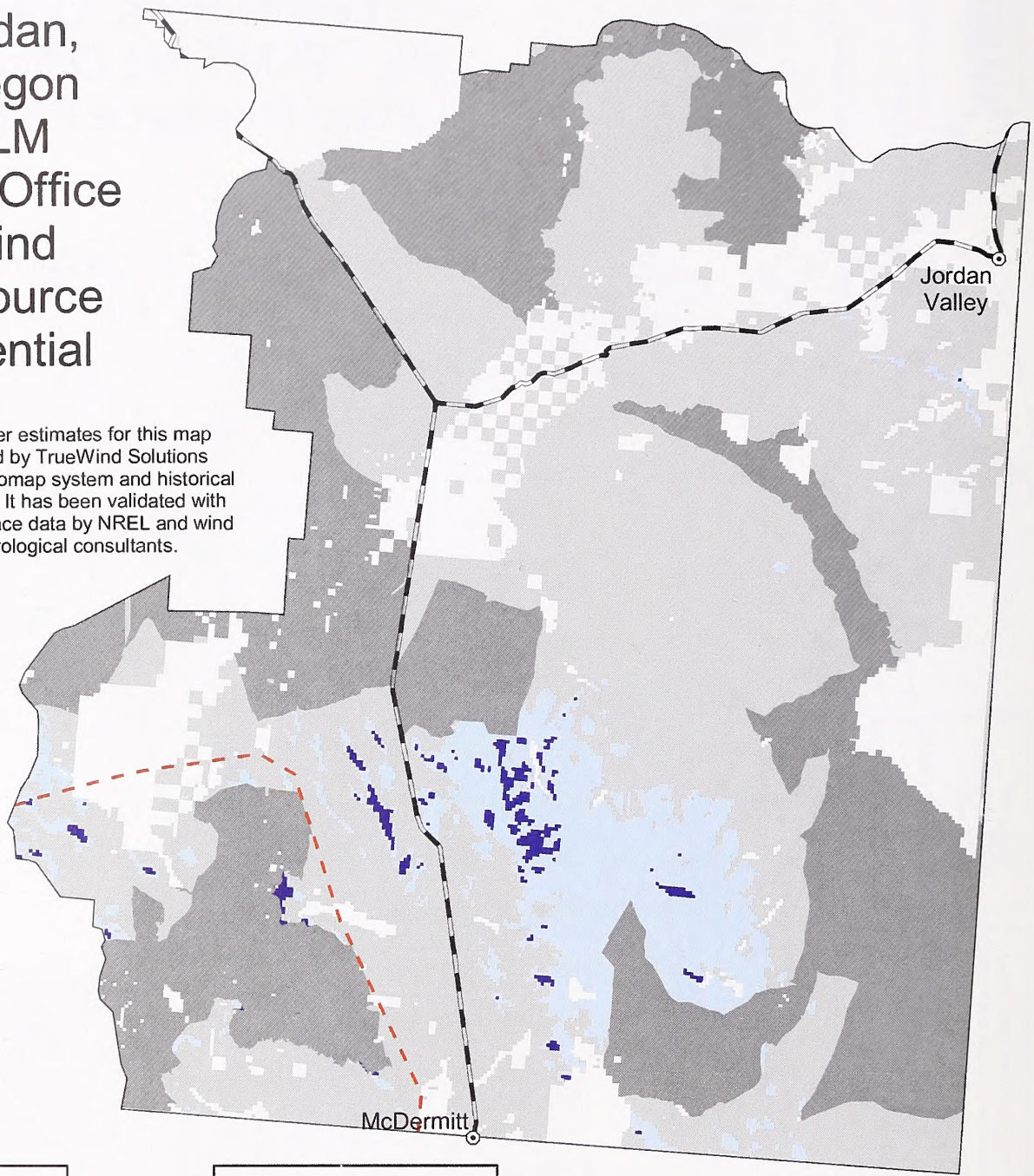
NREL

12-MAY-2004 11.1.11


Grants Pass, Oregon
BLM Field Office
Wind Resource Potential
Merlin
Grants Pass
Murphy
Selma
Cave Junction
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Transmission Line*
Voltage (kV)
69 **
100 -161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
Wind Resource Level
High
Medium
Low
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
10 0 10 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY 2004 11.1.12

Jordan, Oregon BLM Field Office Wind Resource Potential

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.



Wind Resource Level
- High
- Medium
- Low

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

Transmission Line*
Voltage
- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.

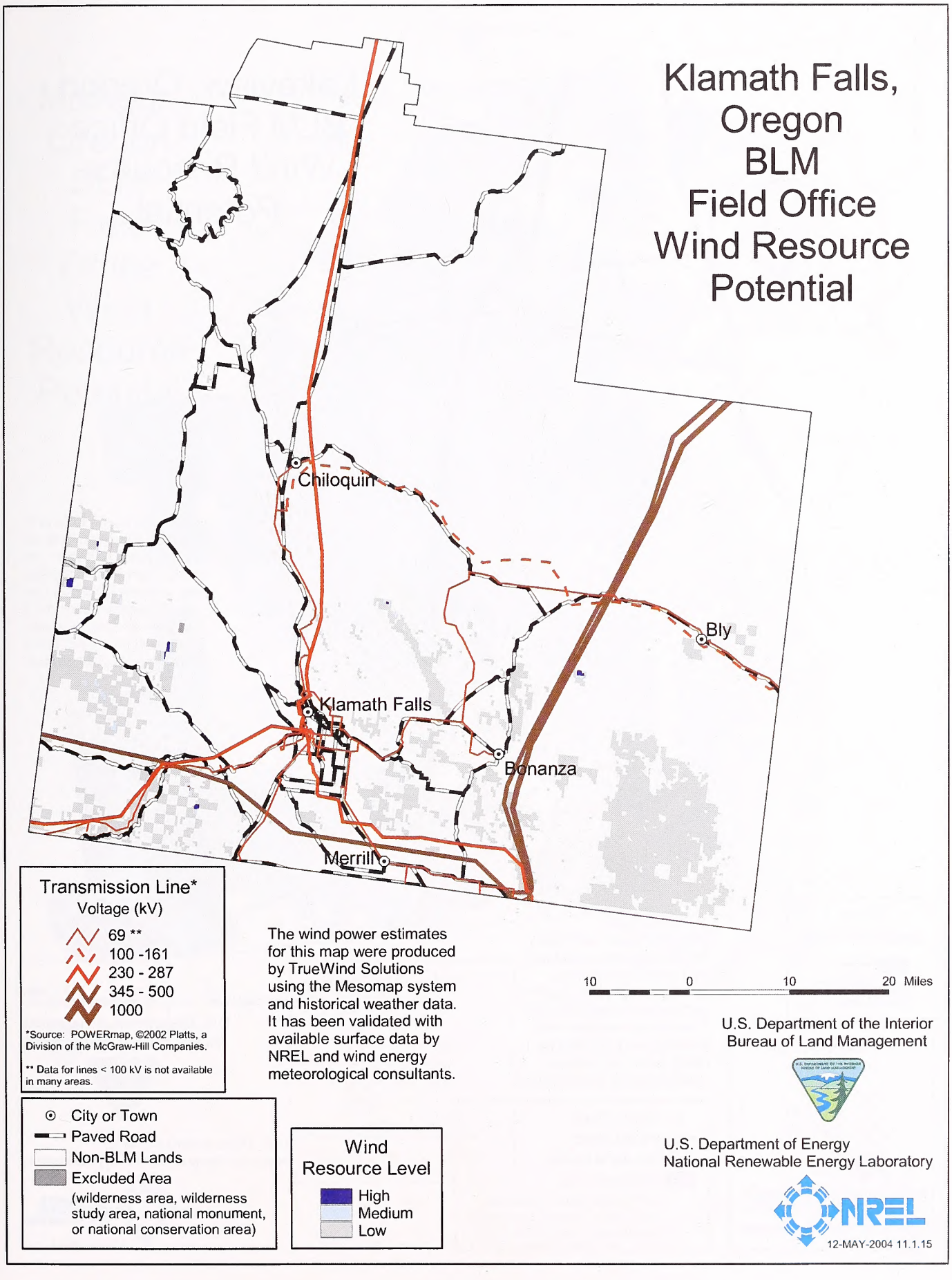
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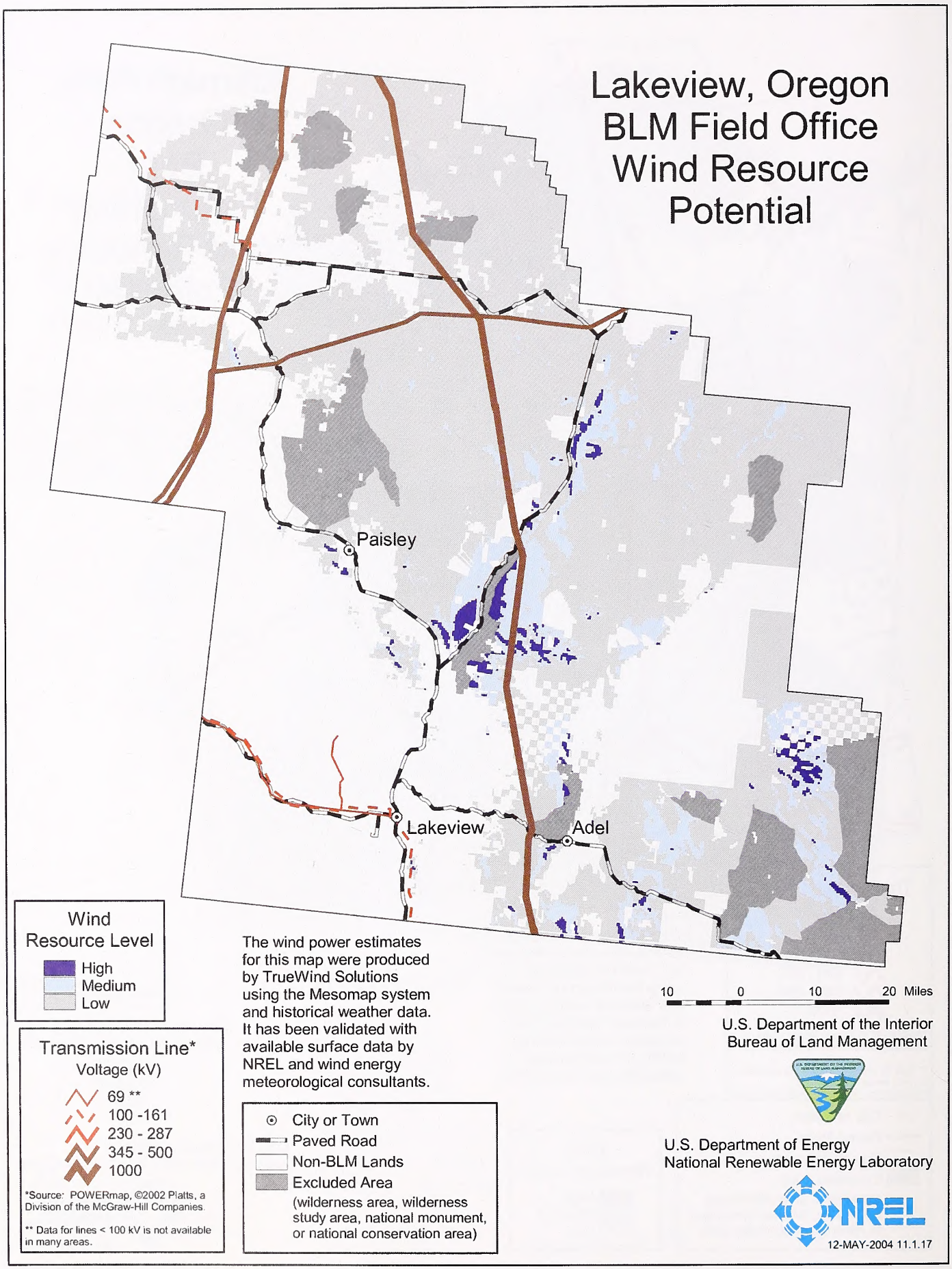
10 0 10 20 Miles

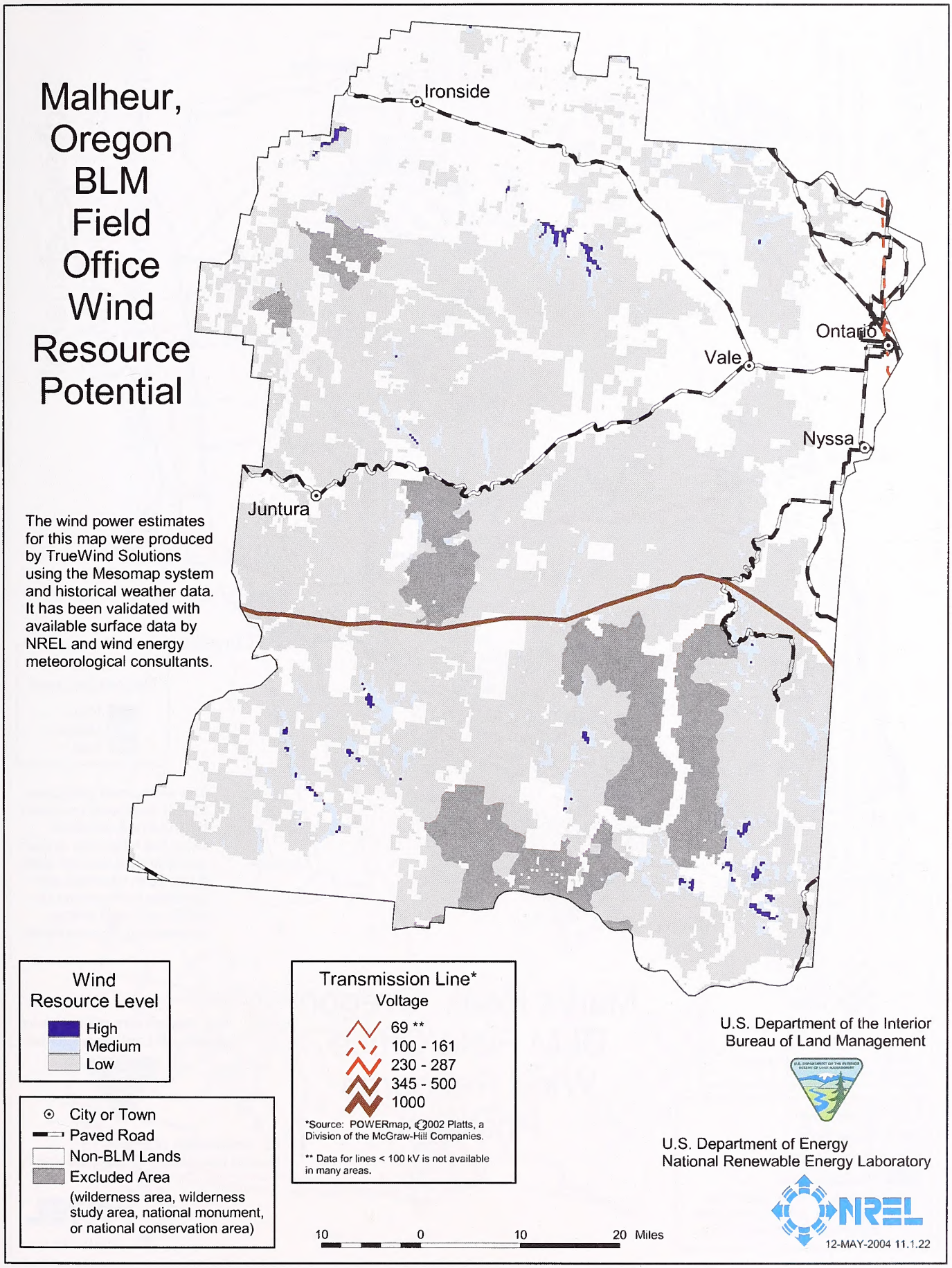
U.S. Department of the Interior
Bureau of Land Management

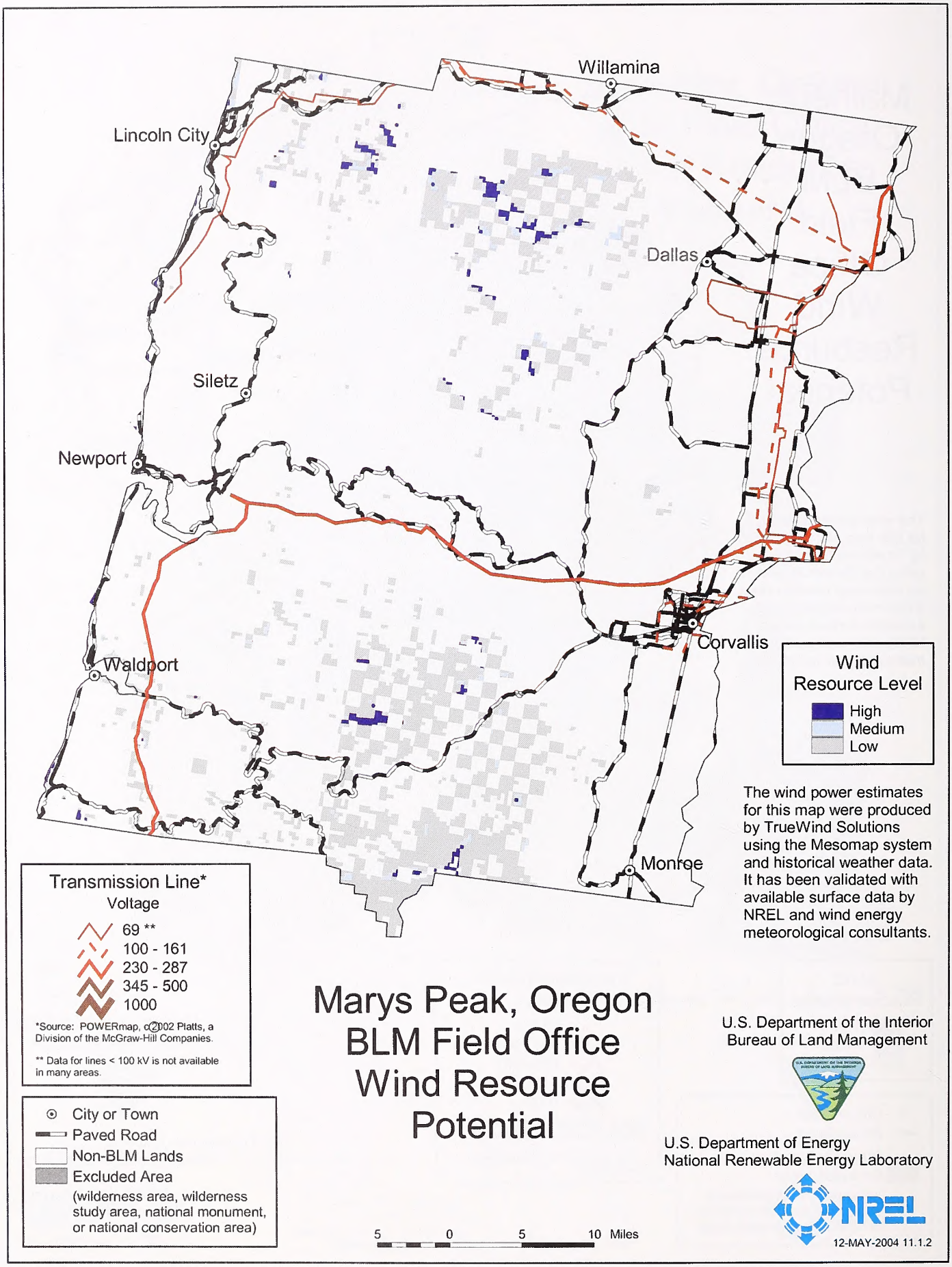
U.S. Department of Energy
National Renewable Energy Laboratory
NREL

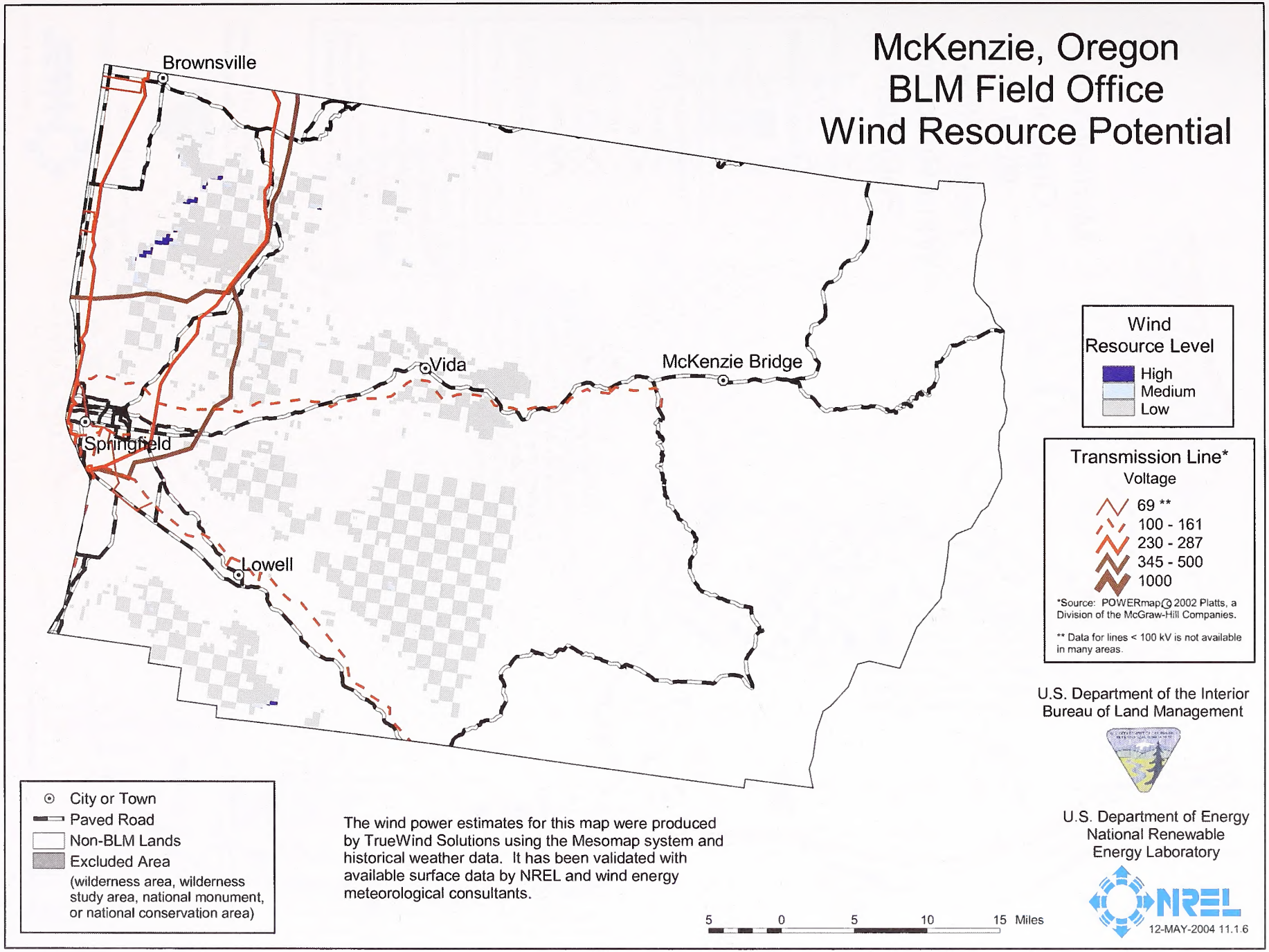
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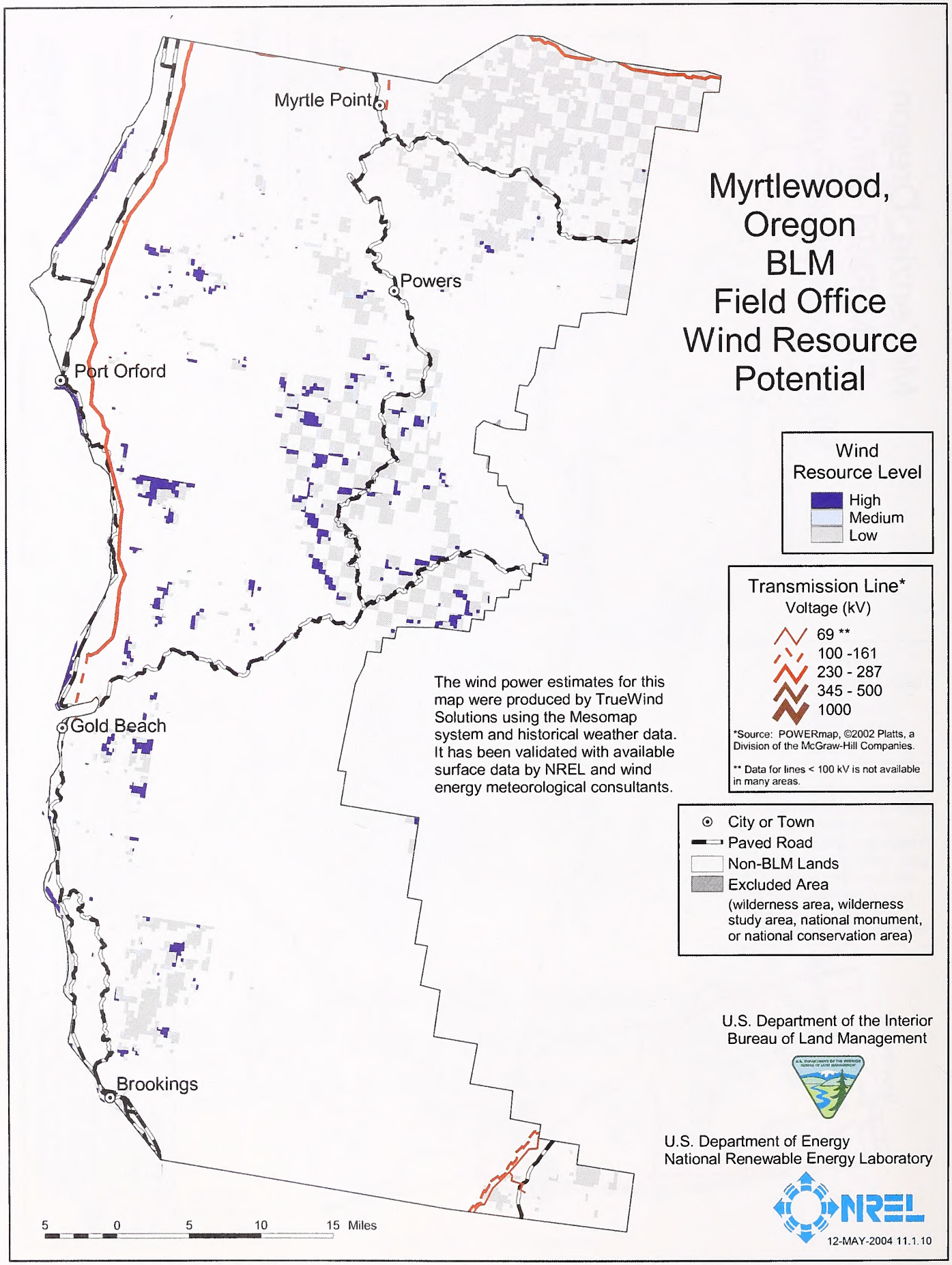

Klamath Falls, Oregon BLM Field Office Wind Resource Potential
Chiloquin
Bly
Klamath Falls
Bonanza
Merrill
Transmission Line*
Voltage (kV)
69 **
100 -161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
10 0 10 20 Miles
U.S. Department of the Interior
Bureau of Land Management
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind Resource Level
High
Medium
Low
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 11.1.15


Lakeview, Oregon
BLM Field Office
Wind Resource
Potential
Paisley
Lakeview
Adel
Wind
Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
10 0 10 20 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 11.1.17
Transmission Line*
Voltage (kV)
69 **
100 -161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)

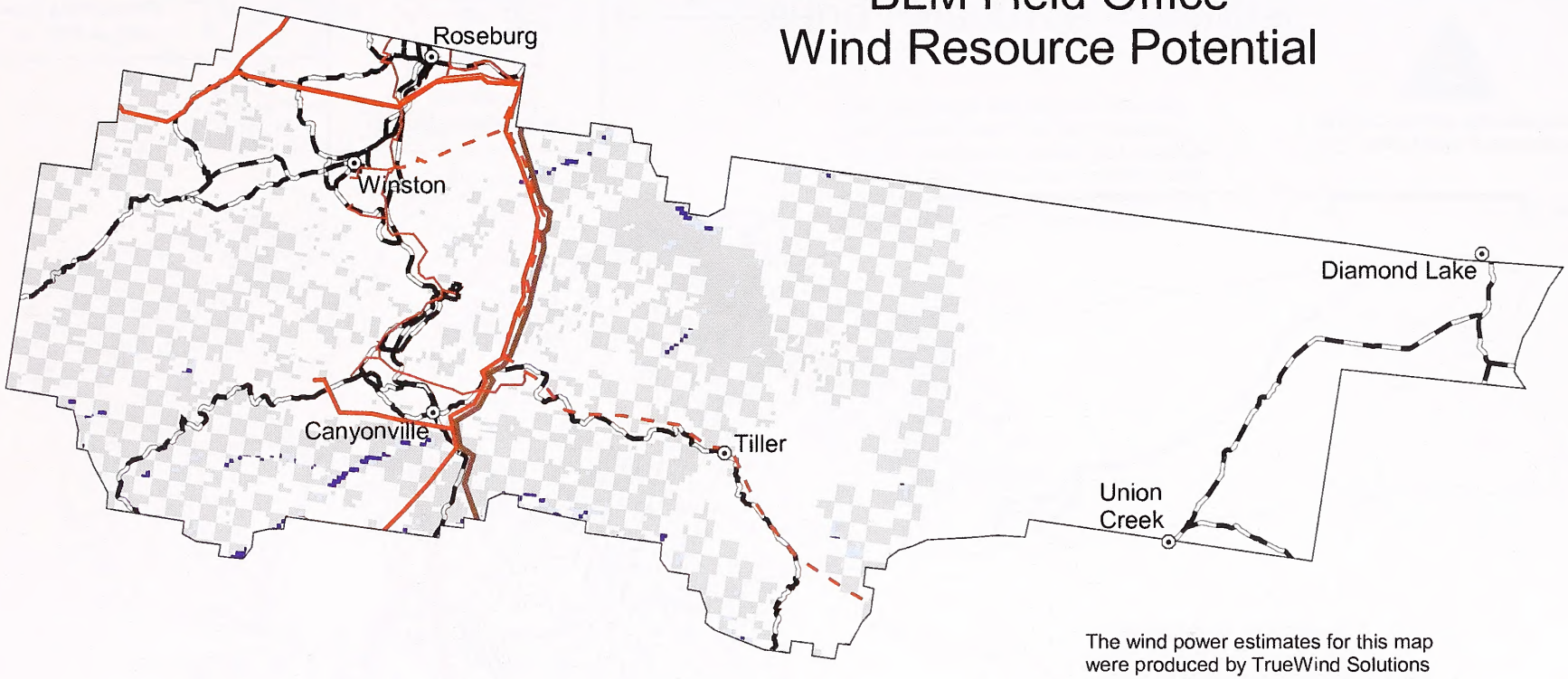

Malheur, Oregon BLM Field Office Wind Resource Potential
Ironside
Ontario
Vale
Nyssa
Juntura
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Transmission Line*
Voltage
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
10 0 10 20 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 11.1.22


Willamina
Lincoln City
Dallas
Siletz
Newport
Corvallis
Waldport
Monroe
Wind Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Transmission Line*
Voltage
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, c2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Marys Peak, Oregon
BLM Field Office
Wind Resource Potential
5 0 5 10 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 11.1.2


McKenzie, Oregon
BLM Field Office
Wind Resource Potential
Brownsville
Springfield
Vida
McKenzie Bridge
Lowell
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap© 2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
U.S. Department of the Interior
Bureau of Land Management
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
5 0 5 10 15 Miles
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
12-MAY-2004 11.1.6


Myrtle Point
Powers
Port Orford
Gold Beach
Brookings
5 0 5 10 15 Miles
Myrtlewood, Oregon BLM Field Office Wind Resource Potential
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 -161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 11.1.10

South River, Oregon
BLM Field Office
Wind Resource Potential



The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

Transmission Line*
Voltage
- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap© 2002 Platts, a Division of the McGraw-Hill Companies.

** Data for lines < 100 kV is not available in many areas.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

Wind Resource Level
- High
- Medium
- Low

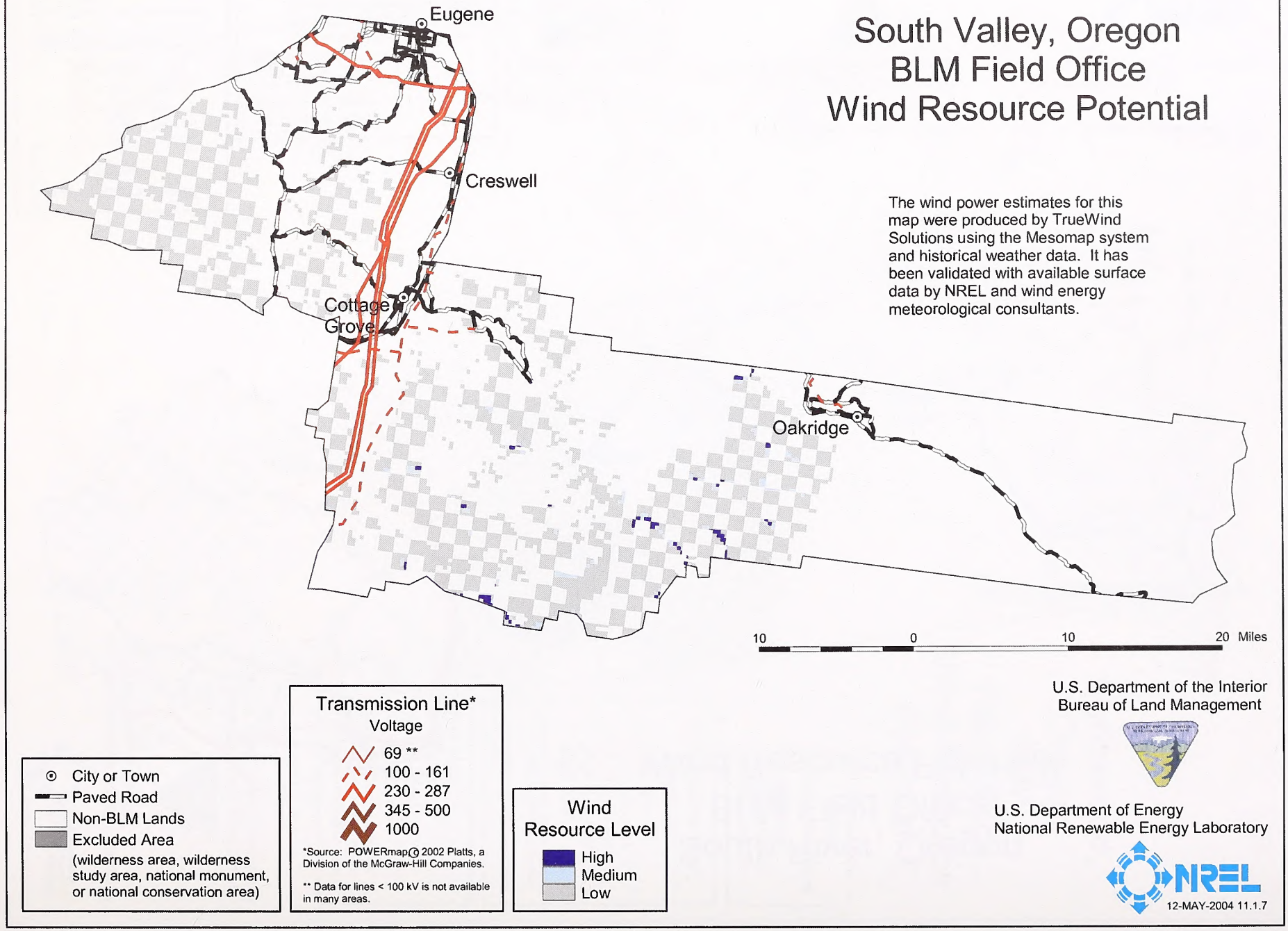
10 0 10 20 Miles

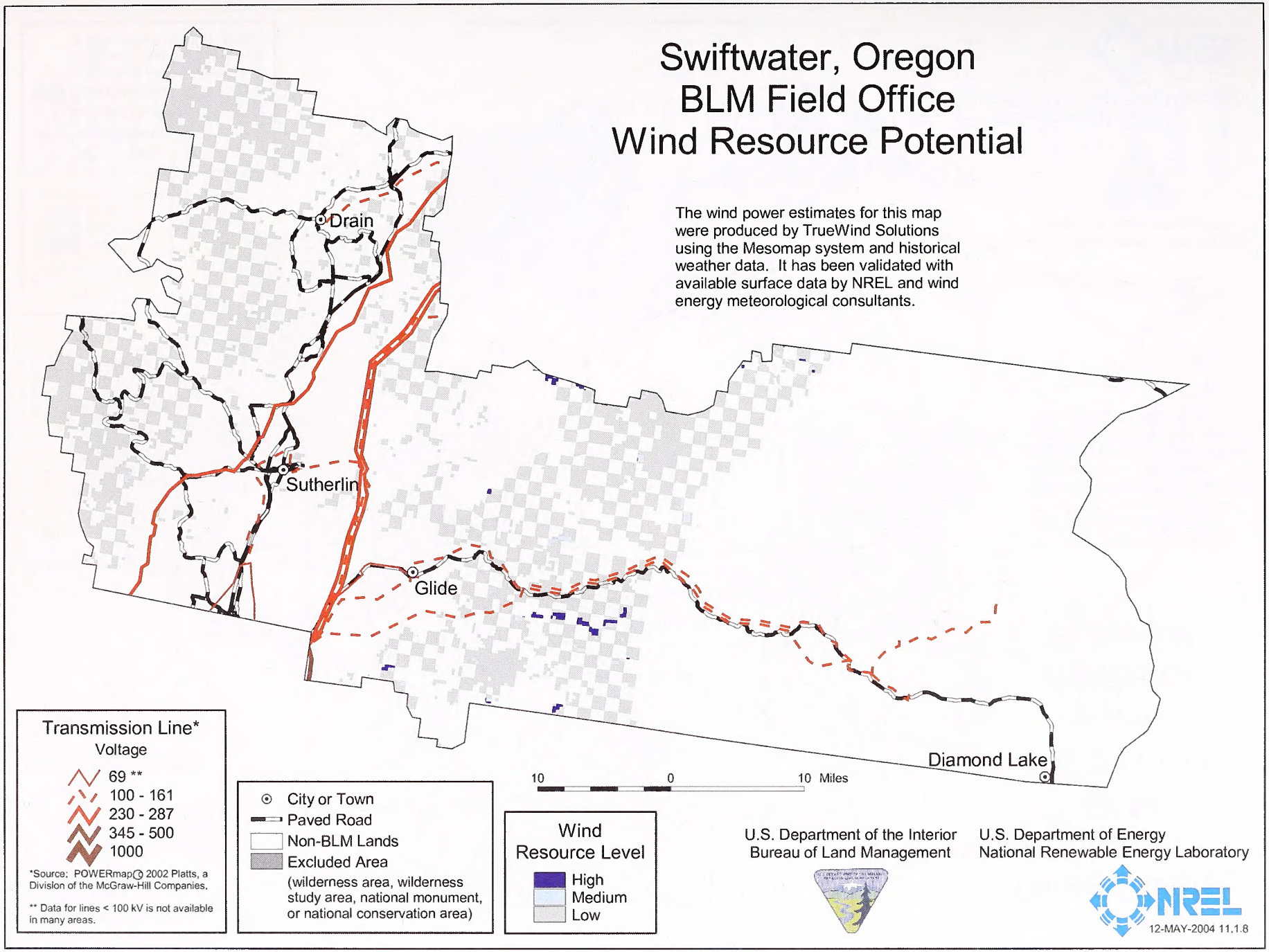
U.S. Department of the Interior
Bureau of Land Management

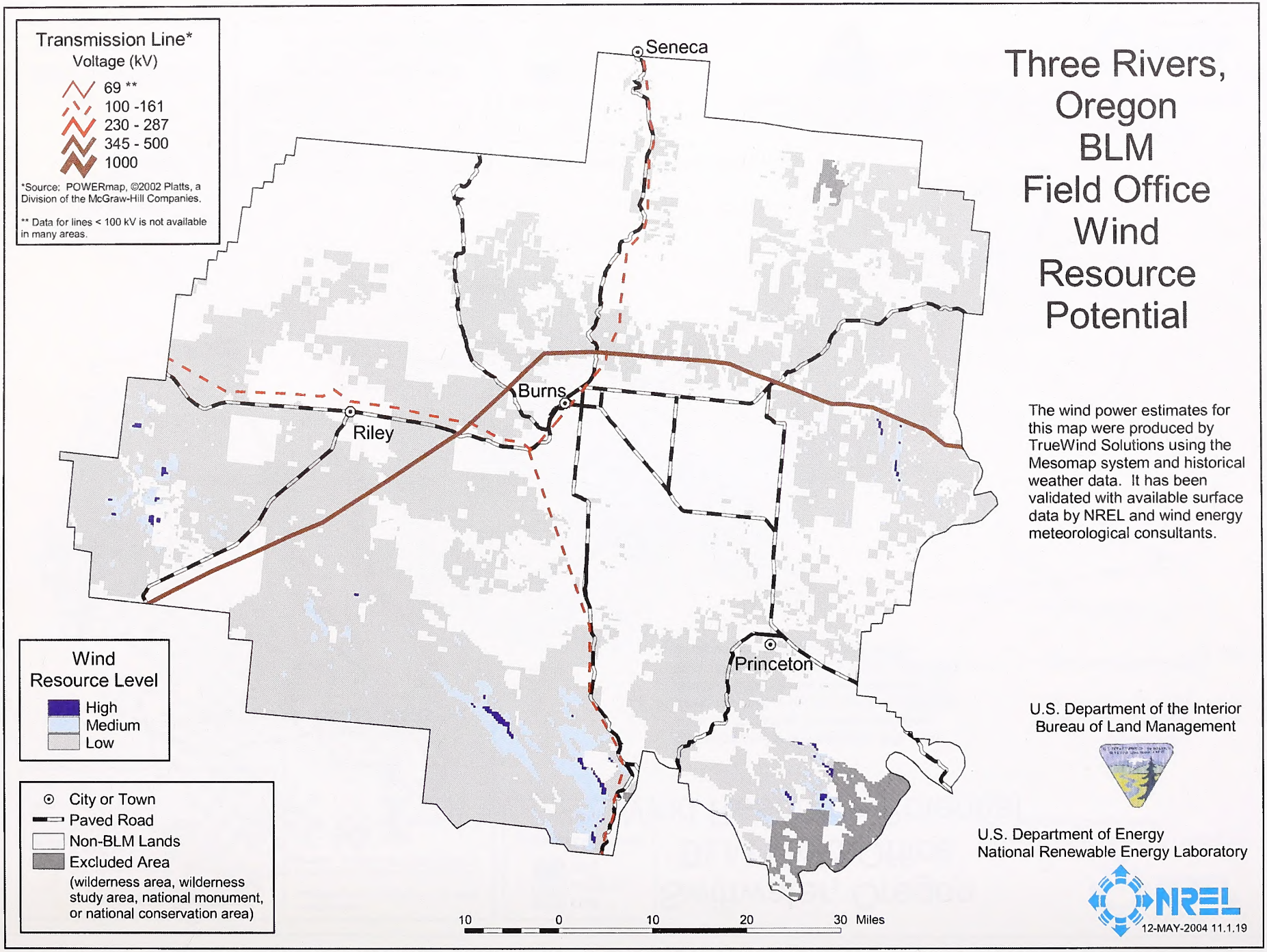
U.S. Department of Energy
National Renewable Energy Laboratory

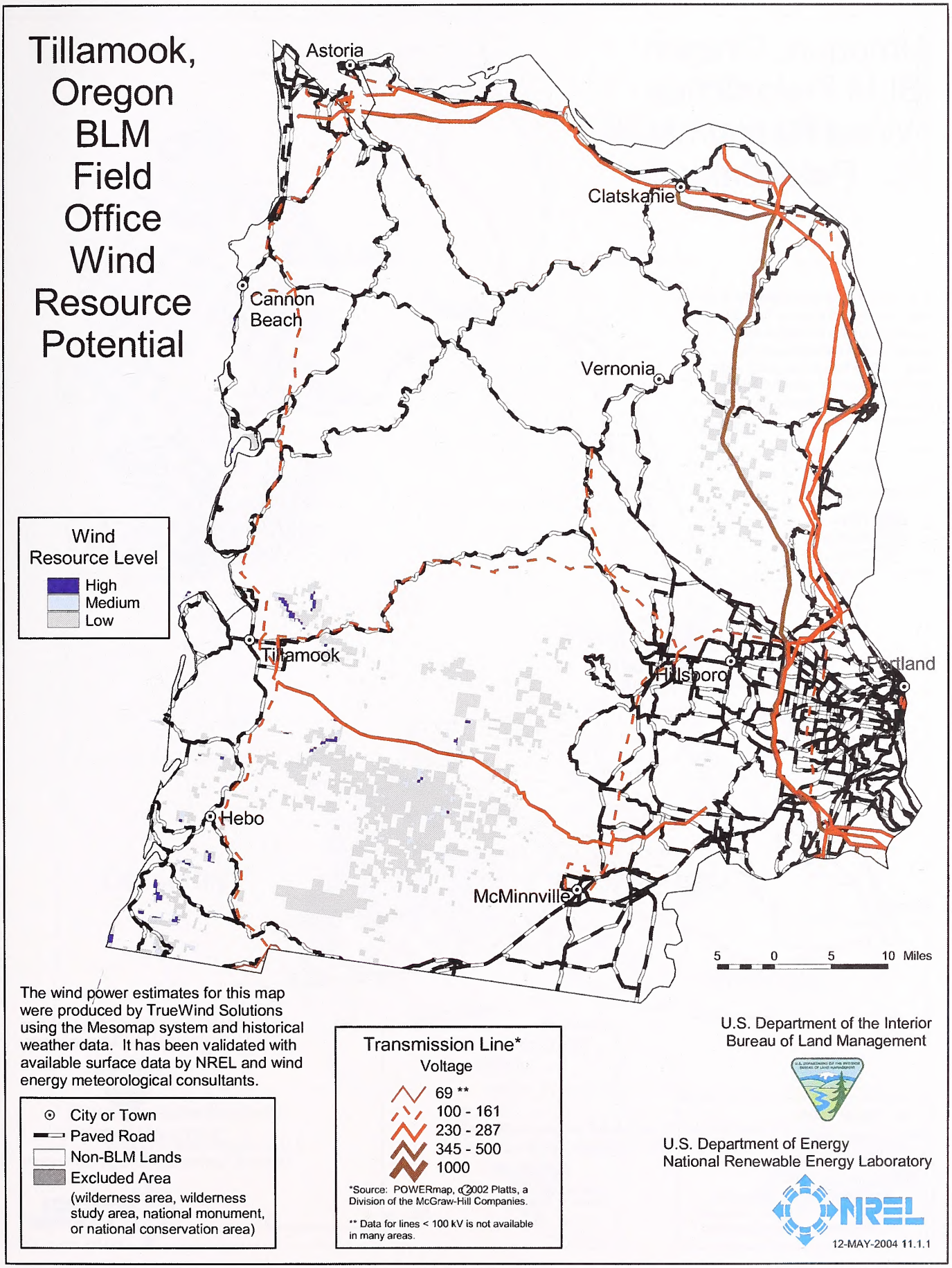
NREL

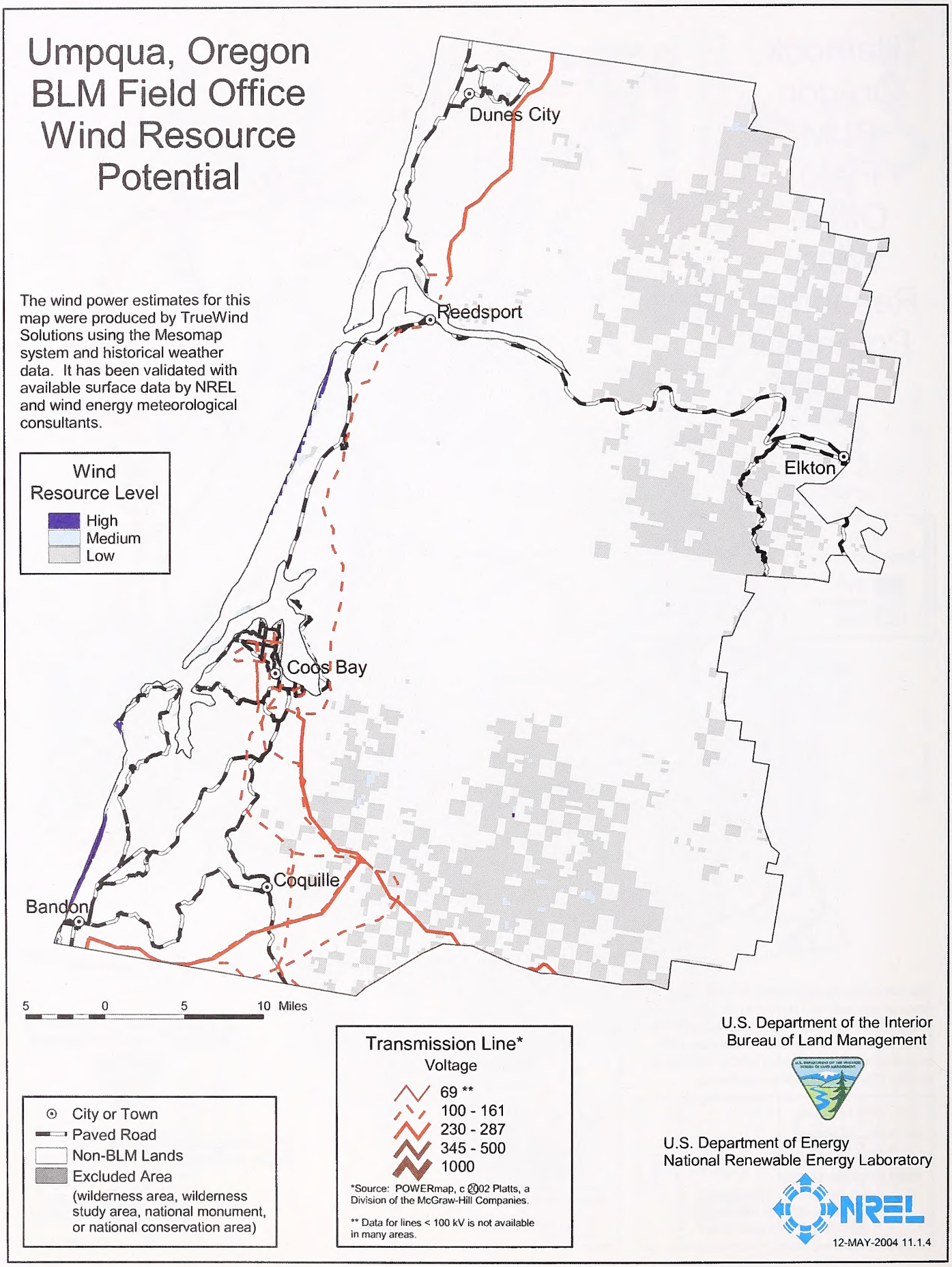
12-MAY-2004 11.1.0


Eugene
Creswell
Cottage Grove
Oakridge
South Valley, Oregon
BLM Field Office
Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
10 0 10 20 Miles
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Transmission Line*
Voltage
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap© 2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
Wind Resource Level
High
Medium
Low
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 11.1.7


Swiftwater, Oregon
BLM Field Office
Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Drain
Sutherlin
Glide
Diamond Lake
10 0 10 Miles
Transmission Line*
Voltage
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap© 2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind Resource Level
High
Medium
Low
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 11.1.8


Transmission Line*
Voltage (kV)
69 **
100 -161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
Seneca
Burns
Riley
Princeton
Three Rivers, Oregon BLM Field Office Wind Resource Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
10 0 10 20 30 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 11.1.19


Tillamook, Oregon BLM Field Office Wind Resource Potential
Astoria
Clatskanie
Cannon Beach
Vernonia
Tillamook
Hillsboro
Portland
Hebo
McMinnville
Wind Resource Level
High
Medium
Low
5 0 5 10 Miles
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Transmission Line*
Voltage
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 11.1.1


Umpqua, Oregon
BLM Field Office
Wind Resource
Potential
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
Dunes City
Reedsport
Elkton
Coos Bay
Coquille
Bandon
5 0 5 10 Miles
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Transmission Line*
Voltage
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, c 2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 11.1.4

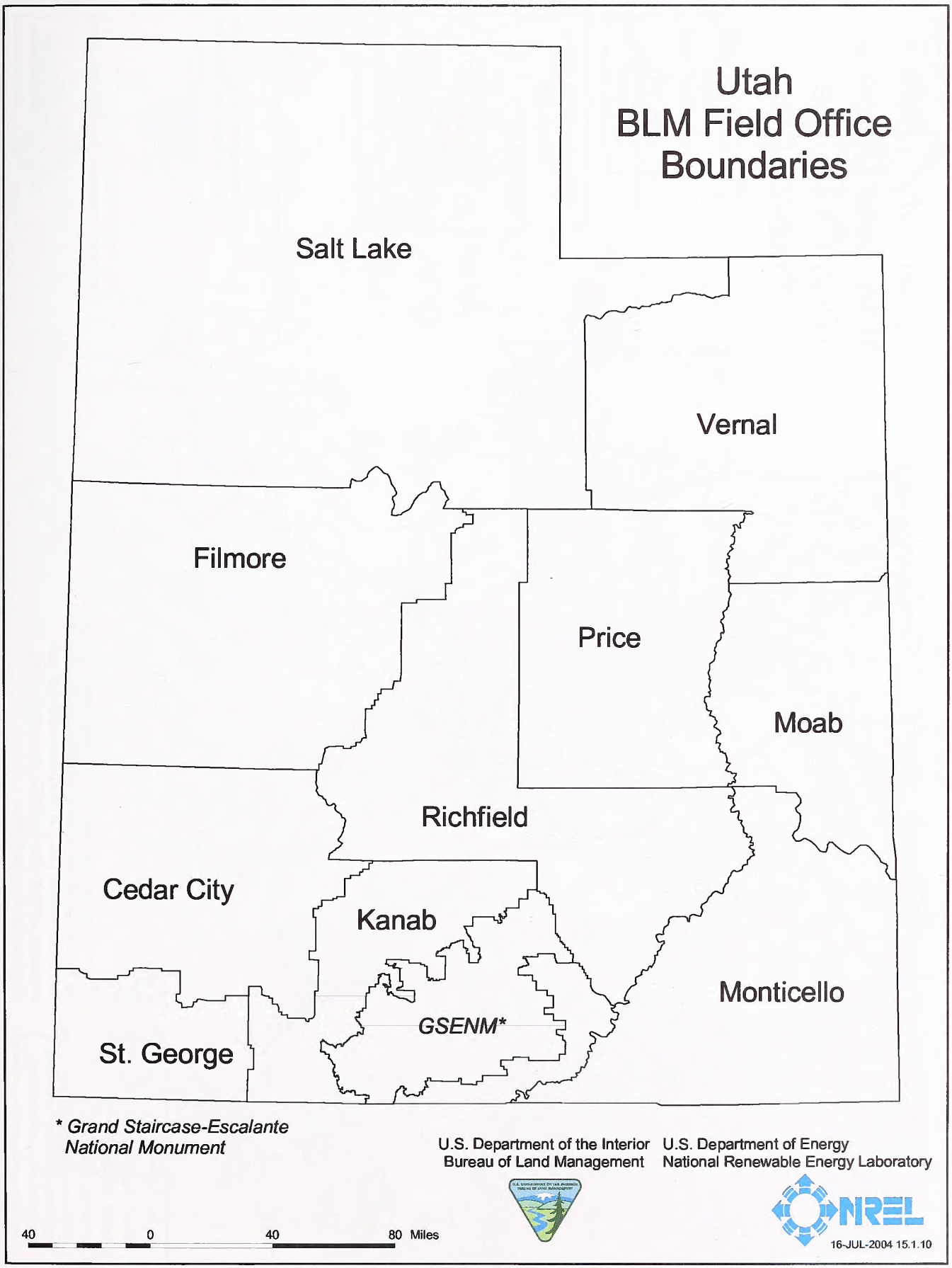
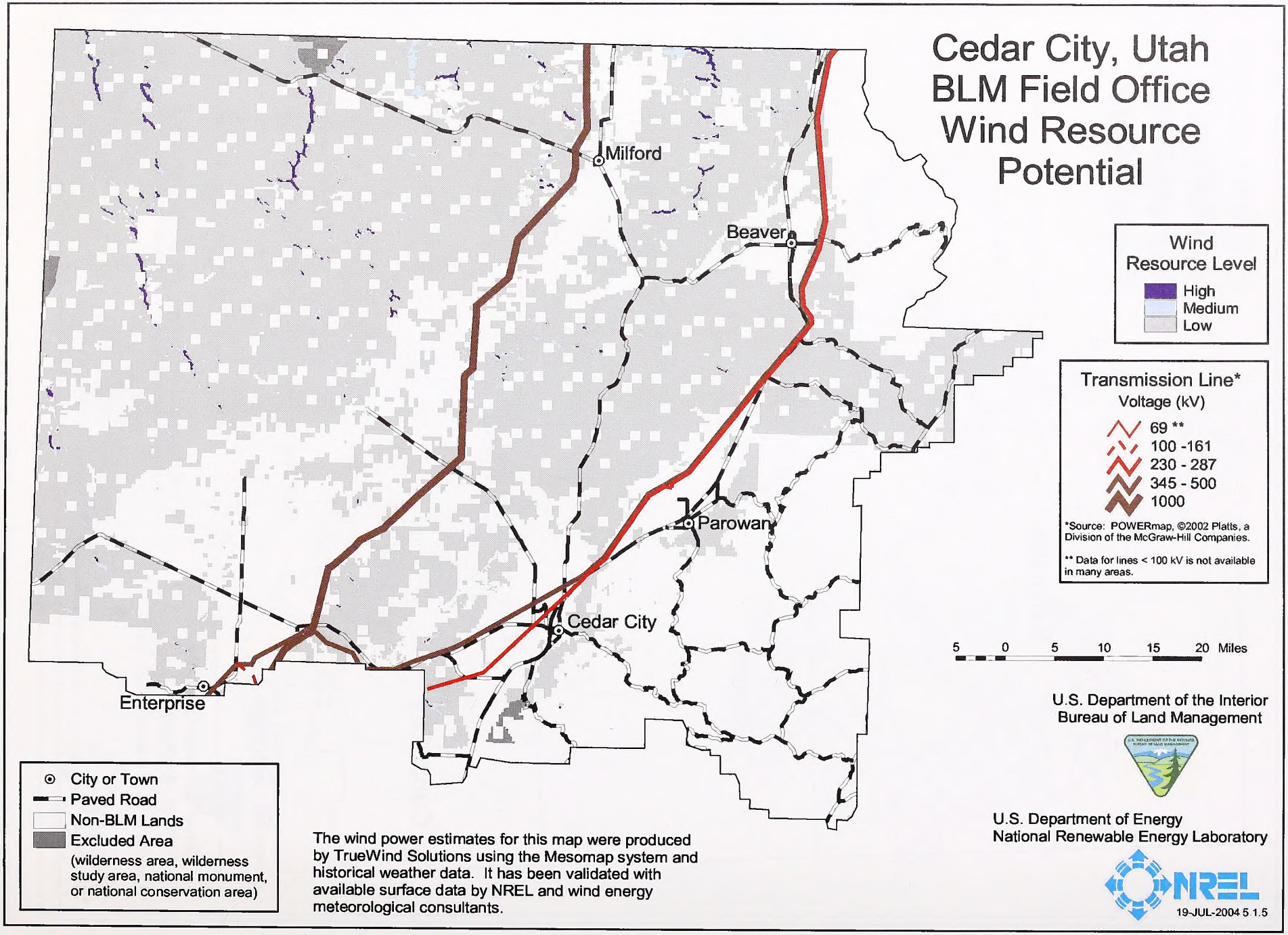
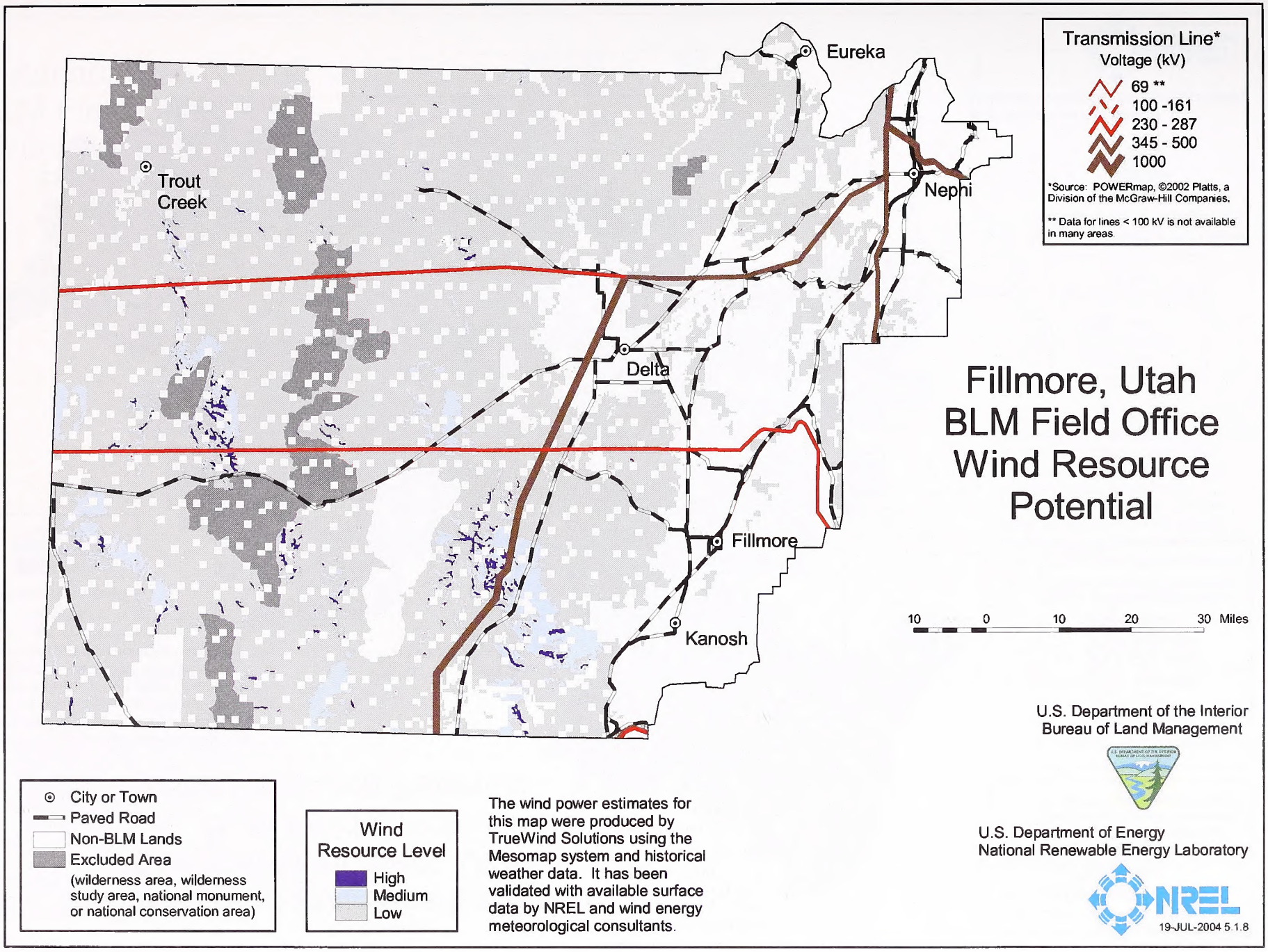


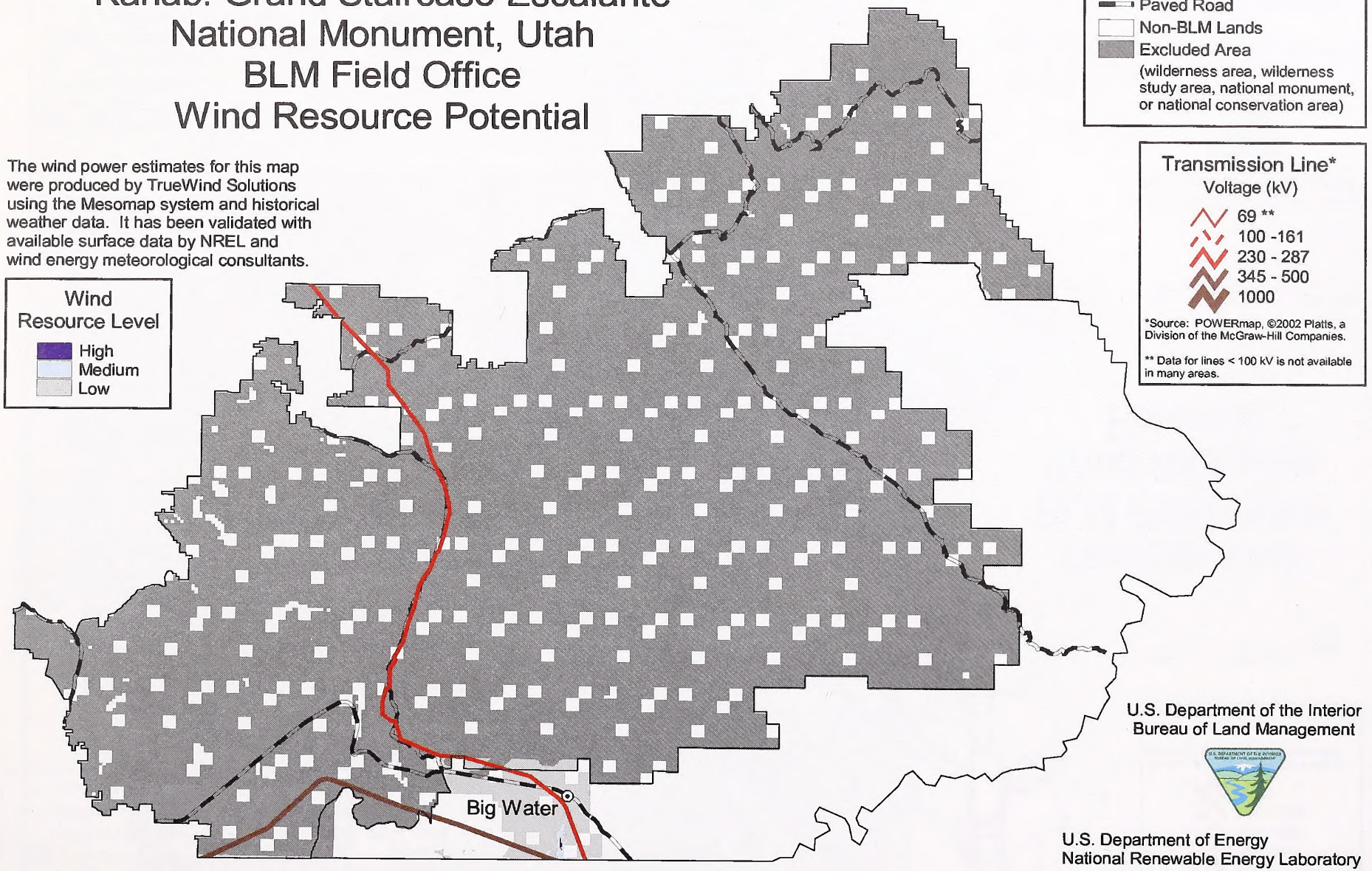
FIGURE B-11 Index Map Showing Locations of Field Office Boundaries in Utah

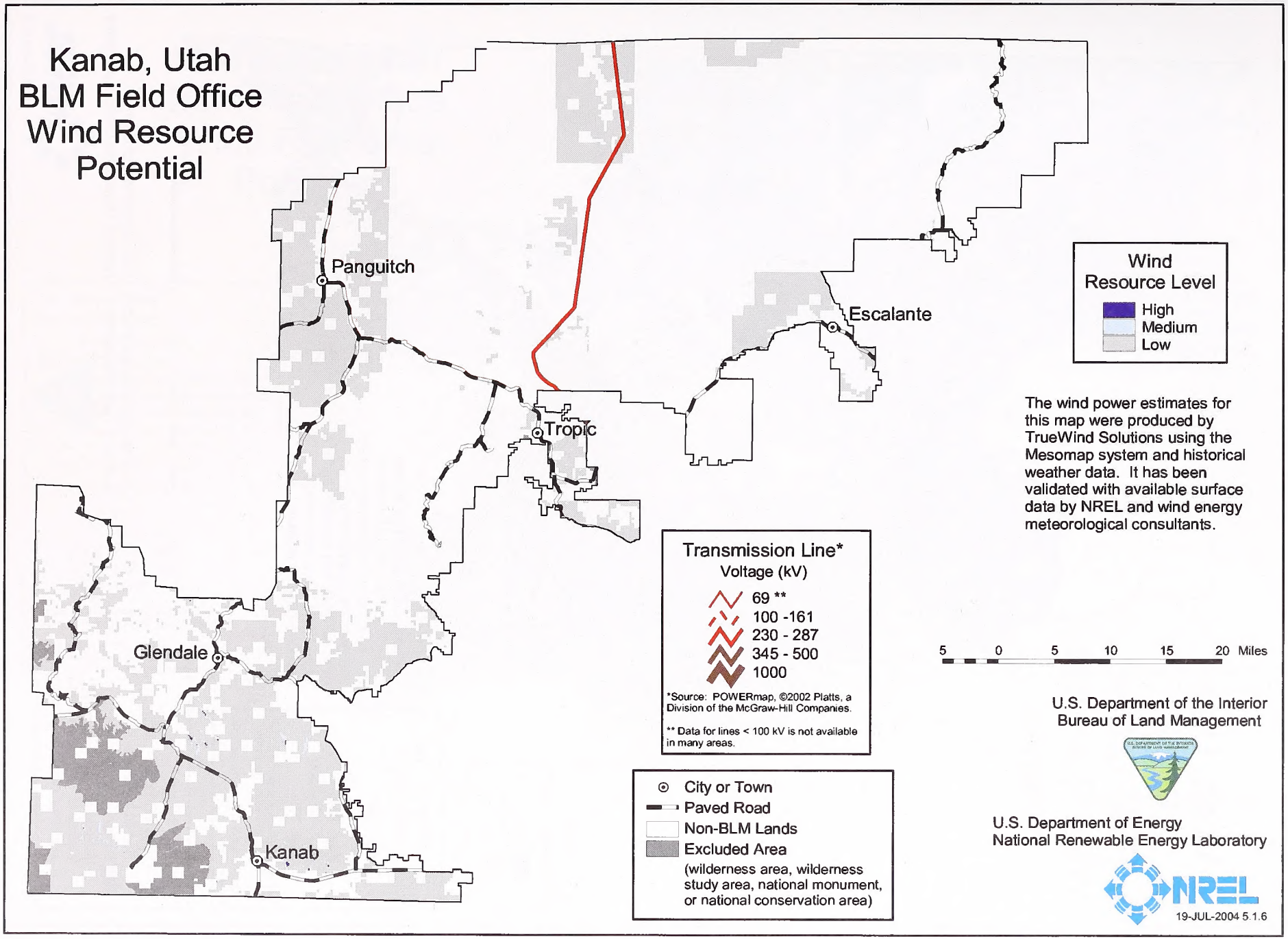

Cedar City, Utah
BLM Field Office
Wind Resource
Potential
Milford
Beaver
Parowan
Cedar City
Enterprise
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 -161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
5 0 5 10 15 20 Miles
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
19-JUL-2004 5 1.5


Eureka
Trout Creek
Nephi
Delta
Fillmore
Kanosh
Transmission Line*
Voltage (kV)
69 **
100 -161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
Fillmore, Utah
BLM Field Office
Wind Resource
Potential
10 0 10 20 30 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
19-JUL-2004 5.1.8
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

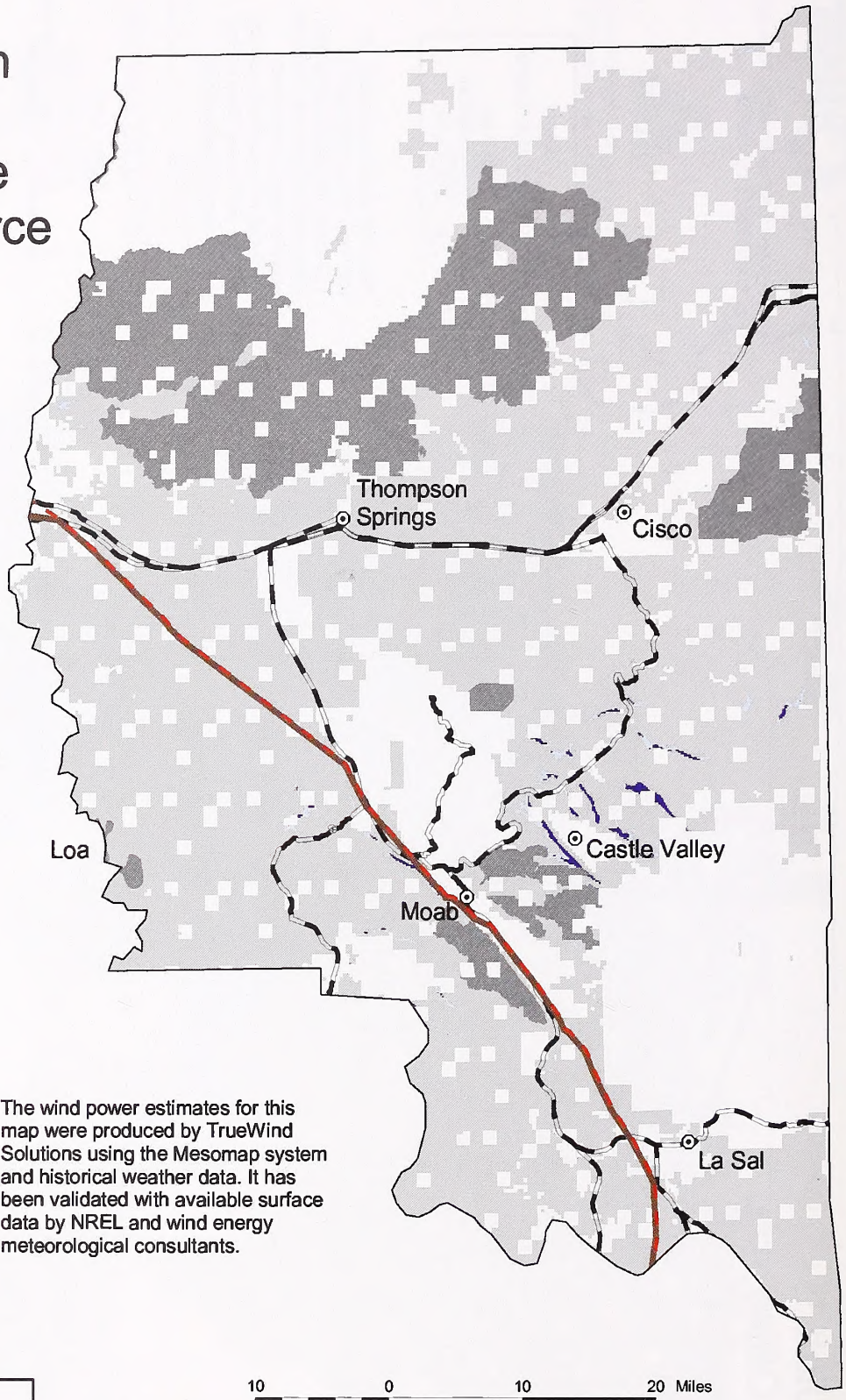
Kanab: Grand Staircase Escalante National Monument, Utah BLM Field Office Wind Resource Potential

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.




Kanab, Utah
BLM Field Office
Wind Resource
Potential
Panguitch
Escalante
Tropic
Glendale
Kanab
Wind
Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Transmission Line*
Voltage (kV)
69 **
100 -161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
5 0 5 10 15 20 Miles
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
19-JUL-2004 5.1.6

Moab, Utah BLM Field Office Wind Resource Potential



Wind Resource Level
- High
- Medium
- Low

Transmission Line*
Voltage (kV)
- 69 **
- 100 -161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.

** Data for lines < 100 kV is not available in many areas.

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

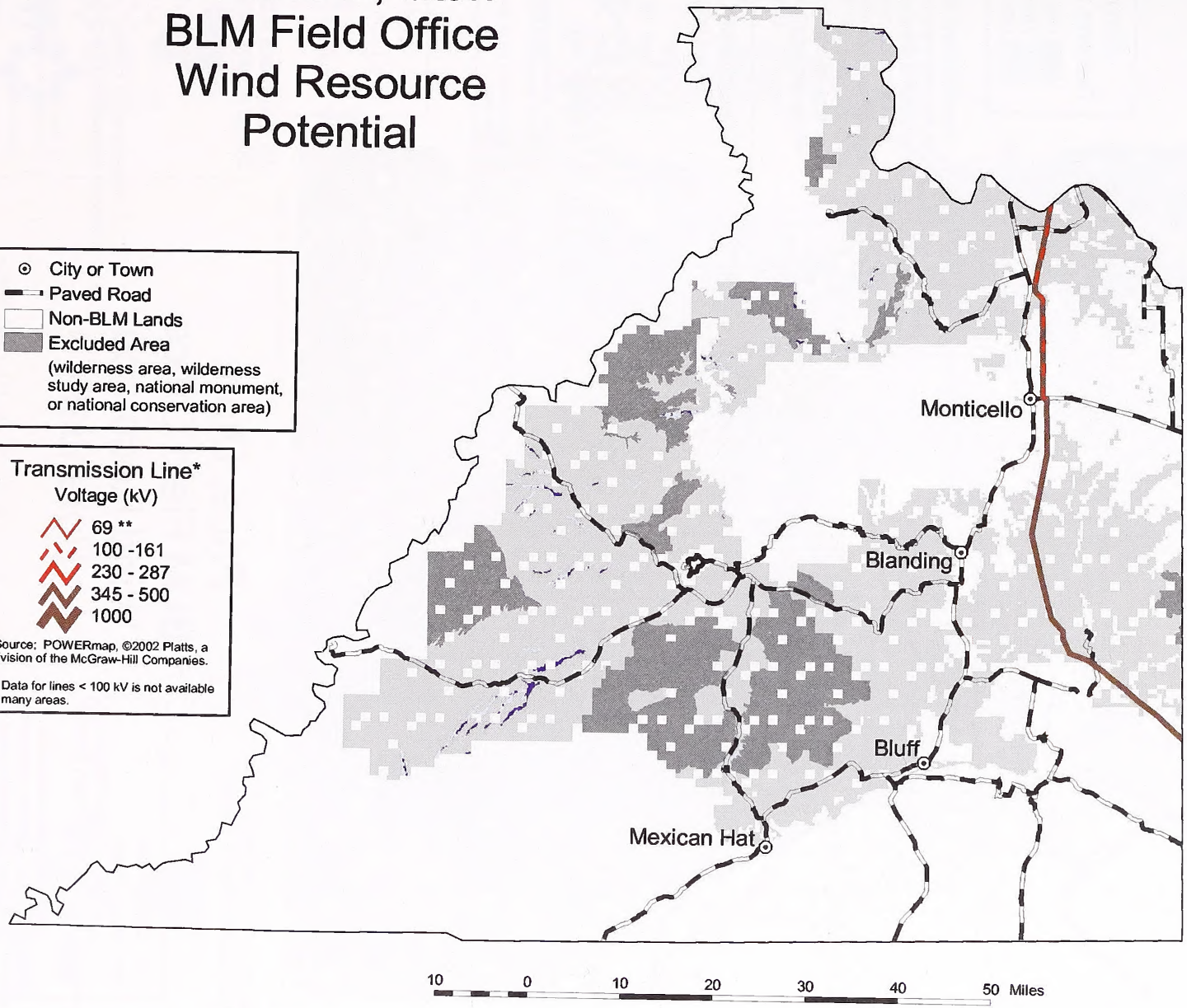
U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

19-JUL-2004 5.1.9

Monticello, Utah BLM Field Office Wind Resource Potential



Wind Resource Level
- High
- Medium
- Low

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area
  (wilderness area, wilderness study area, national monument, or national conservation area)

Transmission Line*
Voltage (kV)
- 69 **
- 100 -161
- 230 - 287
- 345 - 500
- 1000

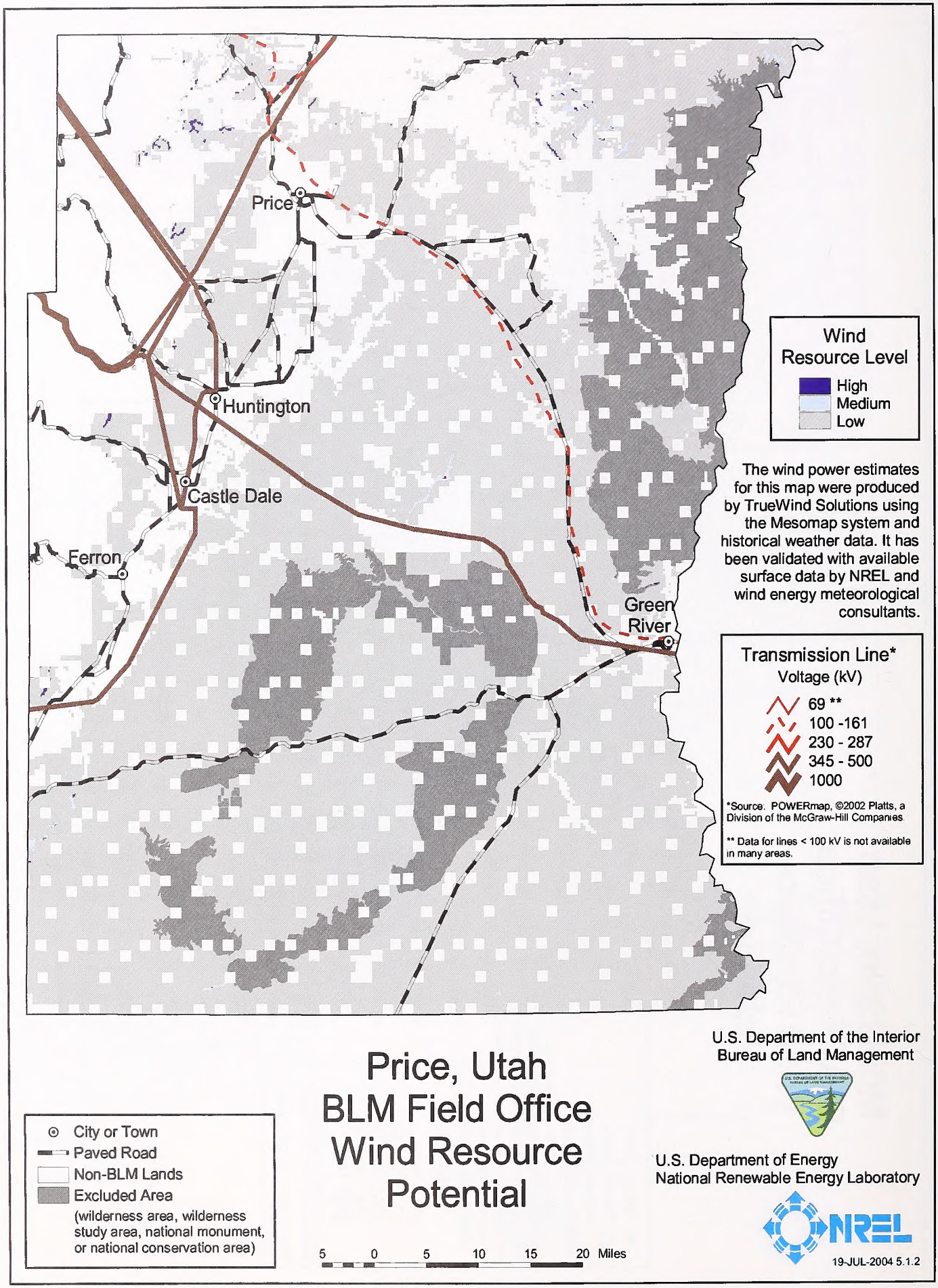
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.

** Data for lines < 100 kV is not available in many areas.

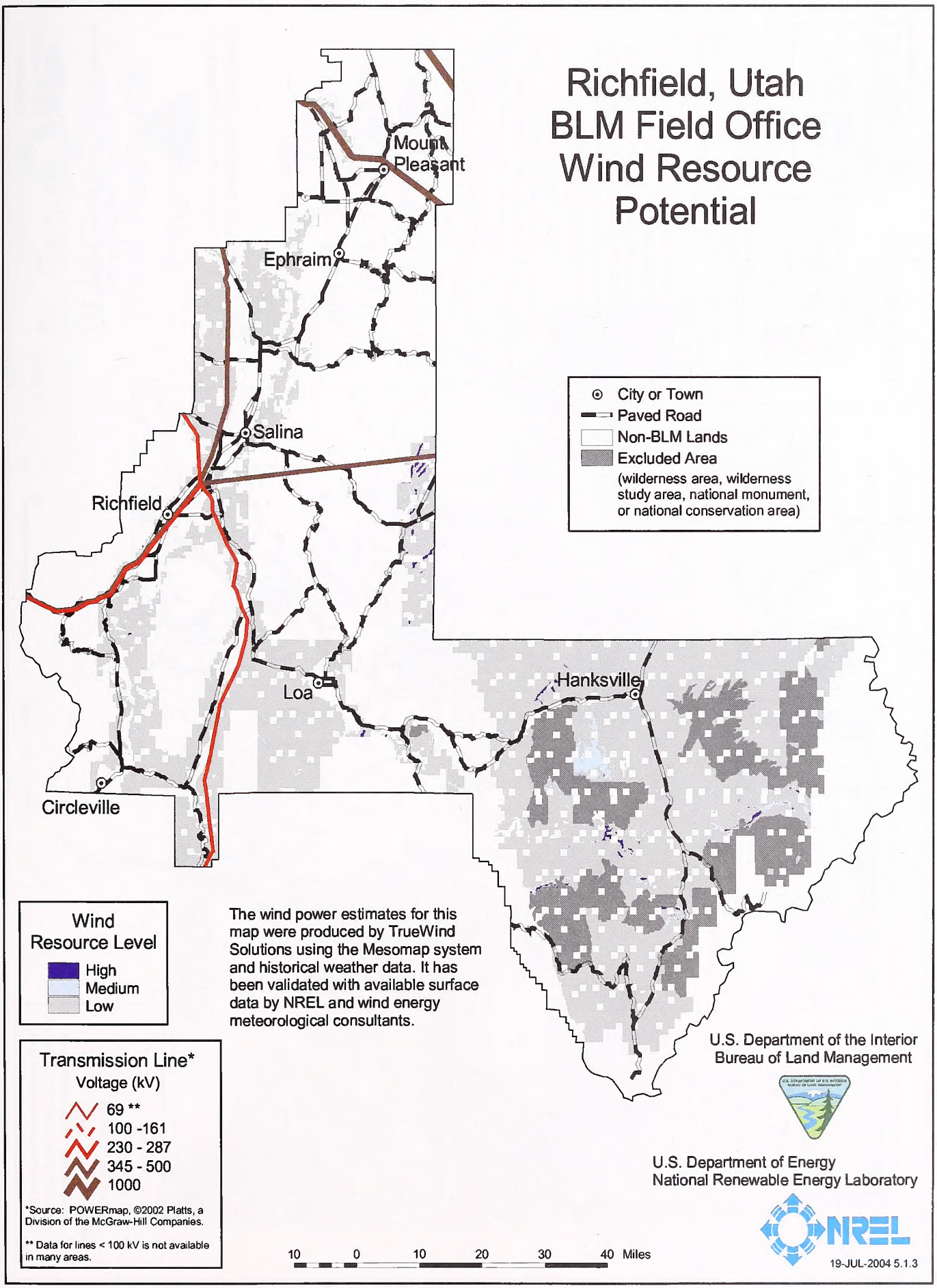
U.S. Department of the Interior
Bureau of Land Management

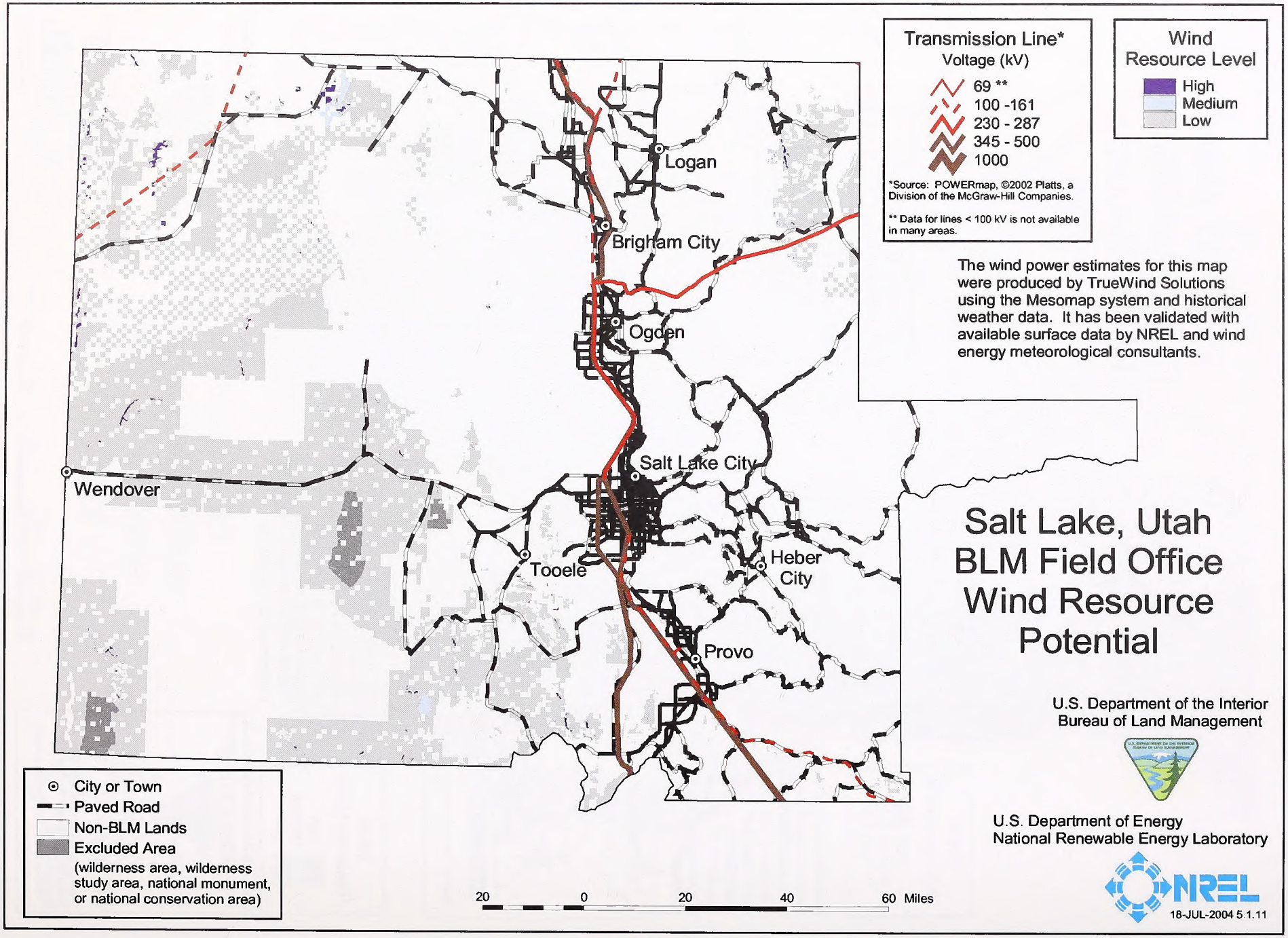
U.S. Department of Energy
National Renewable Energy Laboratory
NREL

19-JUL-2004 5.1.10

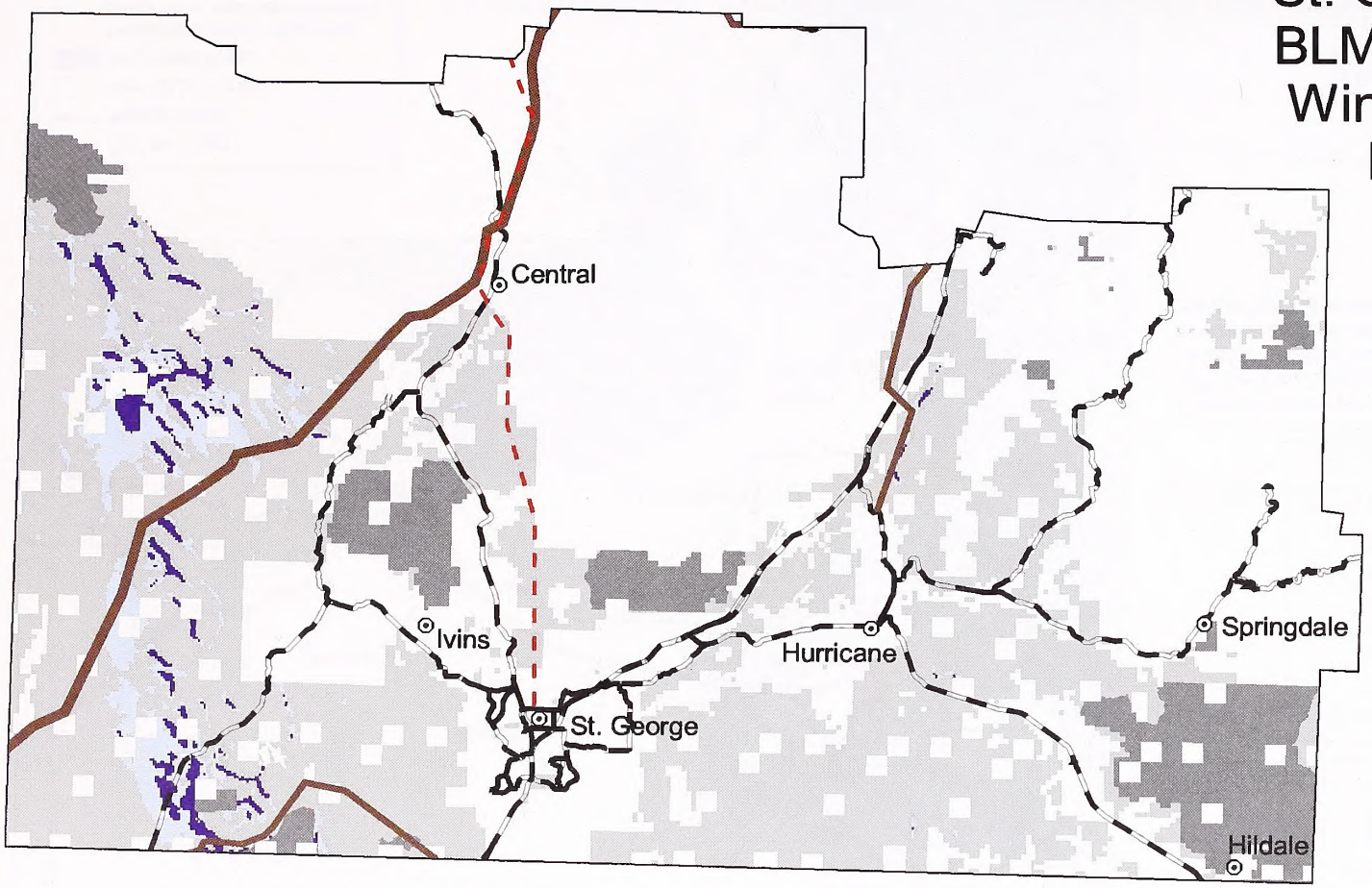


Price, Utah BLM Field Office Wind Resource Potential


Richfield, Utah
BLM Field Office
Wind Resource
Potential
Mount Pleasant
Ephraim
Salina
Richfield
Loa
Hanksville
Circleville
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Transmission Line*
Voltage (kV)
69 **
100 -161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
10 0 10 20 30 40 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
19-JUL-2004 5.1.3


Transmission Line*
Voltage (kV)
69 **
100 -161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
Wind Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Logan
Brigham City
Ogden
Salt Lake City
Wendover
Tooele
Heber City
Provo
Salt Lake, Utah
BLM Field Office
Wind Resource Potential
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
18-JUL-2004 5:1.11
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
20 0 20 40 60 Miles

St. George, Utah BLM Field Office Wind Resource Potential



Wind Resource Level
- High
- Medium
- Low

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

Transmission Line*
Voltage (kV)
- 69 **
- 100 -161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.

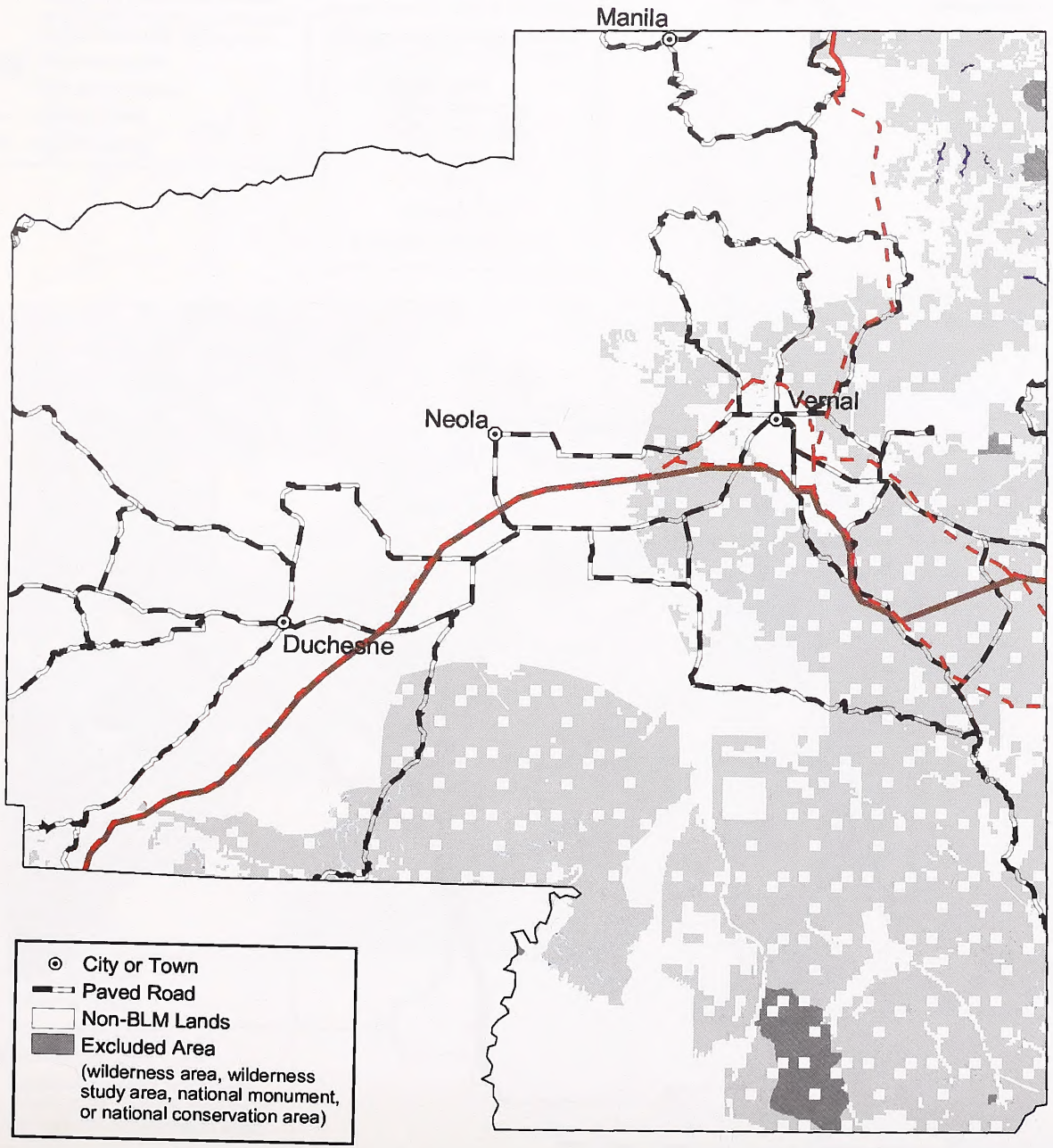
** Data for lines < 100 kV is not available in many areas.

5 0 5 10 15 Miles

U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory
NREL

19-JUL-2004 5.1.7



Vernal, Utah BLM Field Office Wind Resource Potential

Wind Resource Level
- High
- Medium
- Low

Transmission Line*
Voltage (kV)
- 69 **
- 100 -161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.

** Data for lines < 100 kV is not available in many areas.

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

19-JUL-2004 5.1.1

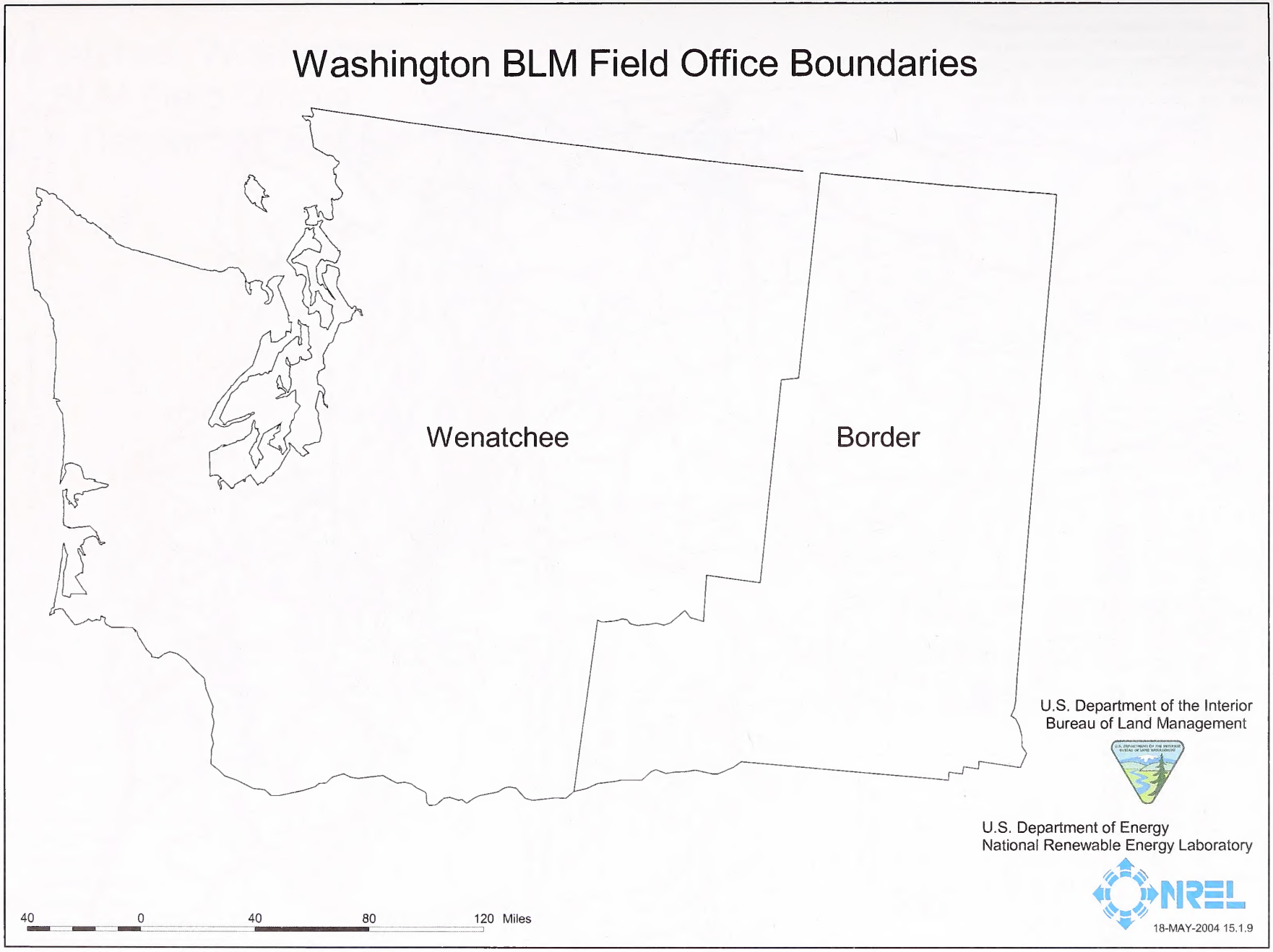
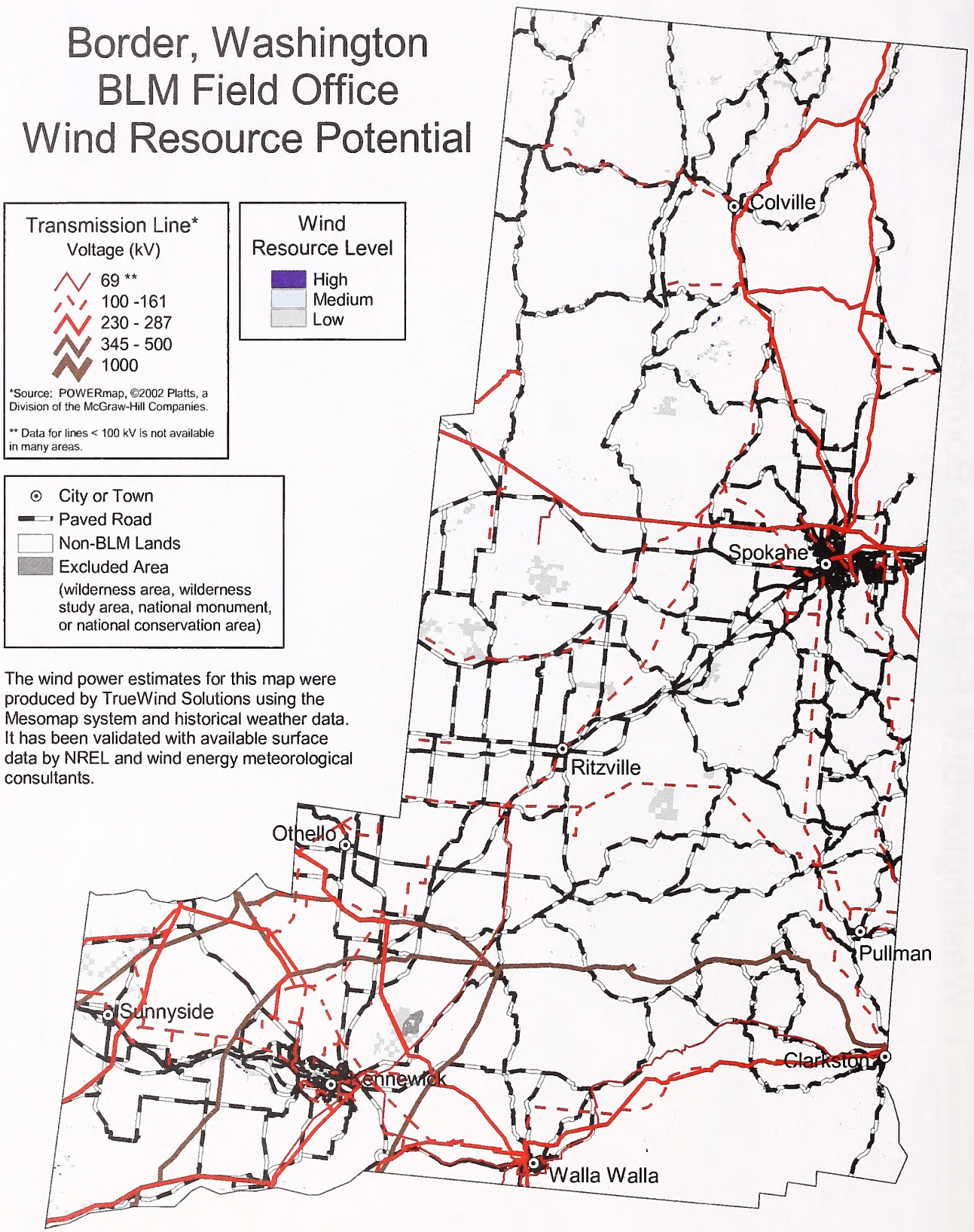


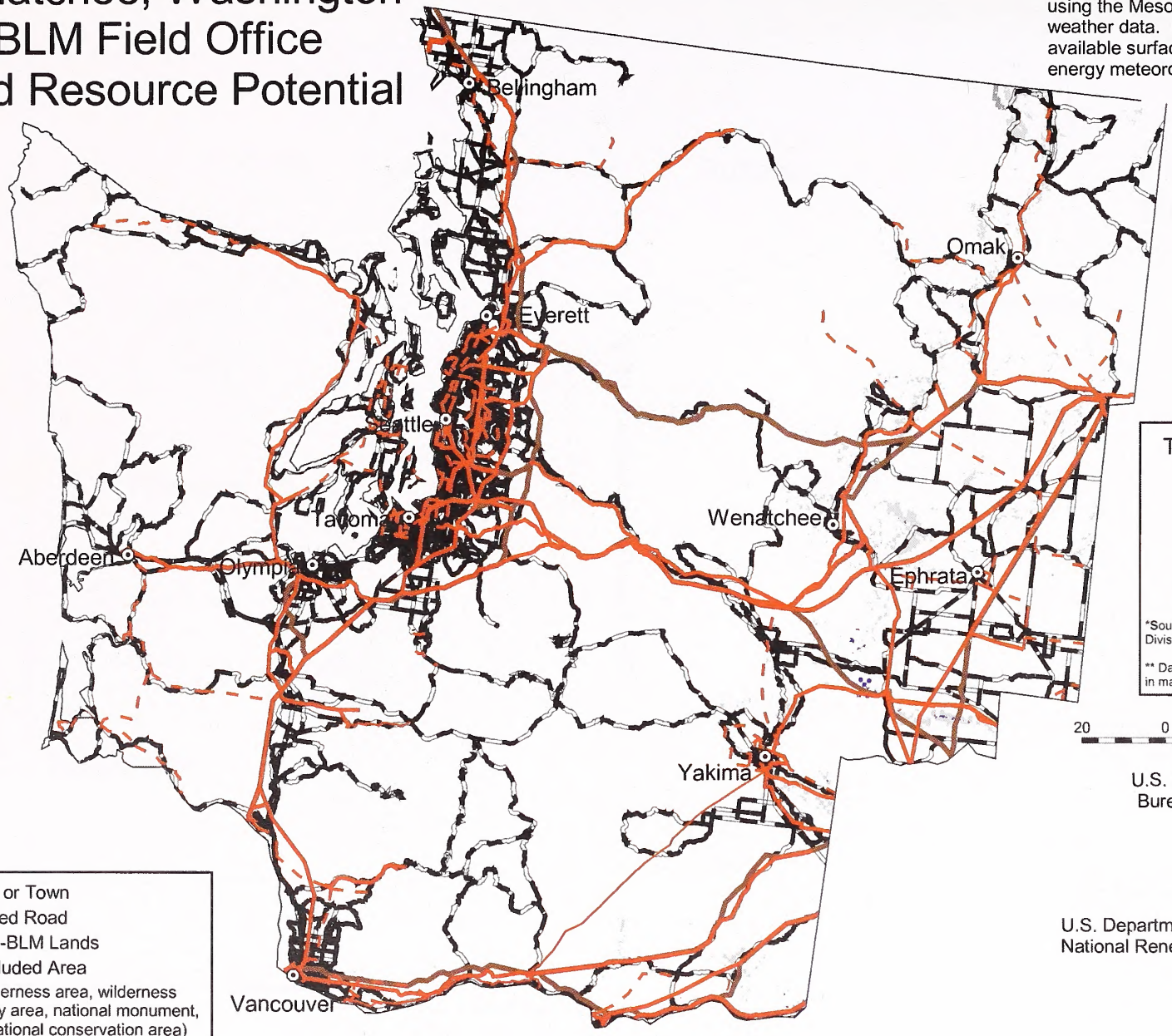
FIGURE B-12 Index Map Showing Locations of Field Office Boundaries in Washington

Border, Washington BLM Field Office Wind Resource Potential



Wenatchee, Washington
BLM Field Office
Wind Resource Potential

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.



Wind Resource Level
- High
- Medium
- Low

Transmission Line*
Voltage (kV)
- 69 **
- 100 -161
- 230 - 287
- 345 - 500
- 1000

*Source; POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.

** Data for lines < 100 kV is not available in many areas.

20 0 20 40 Miles

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Energy
National Renewable Energy Laboratory
NREL

17-MAY-2004 14.1.1

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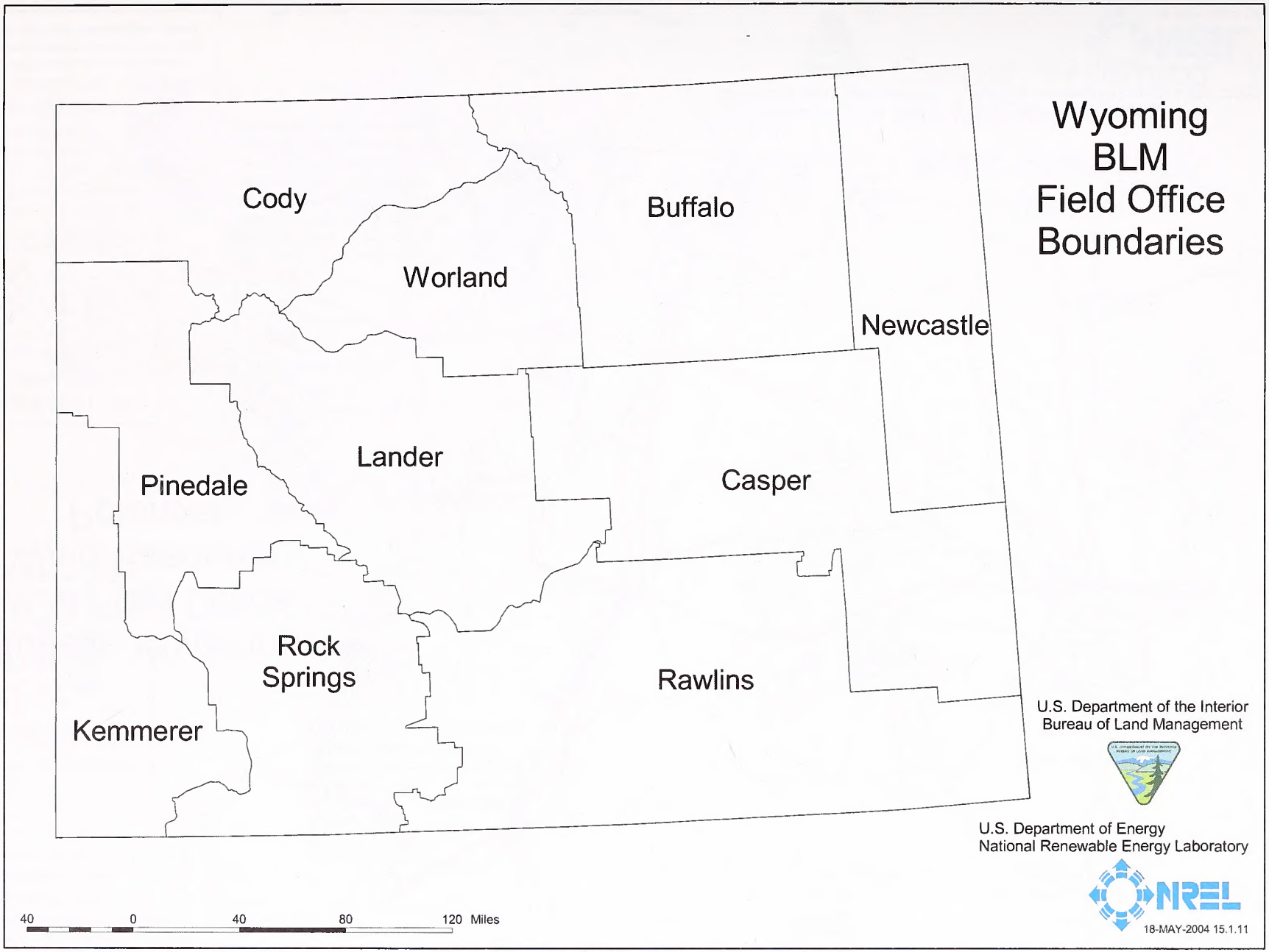
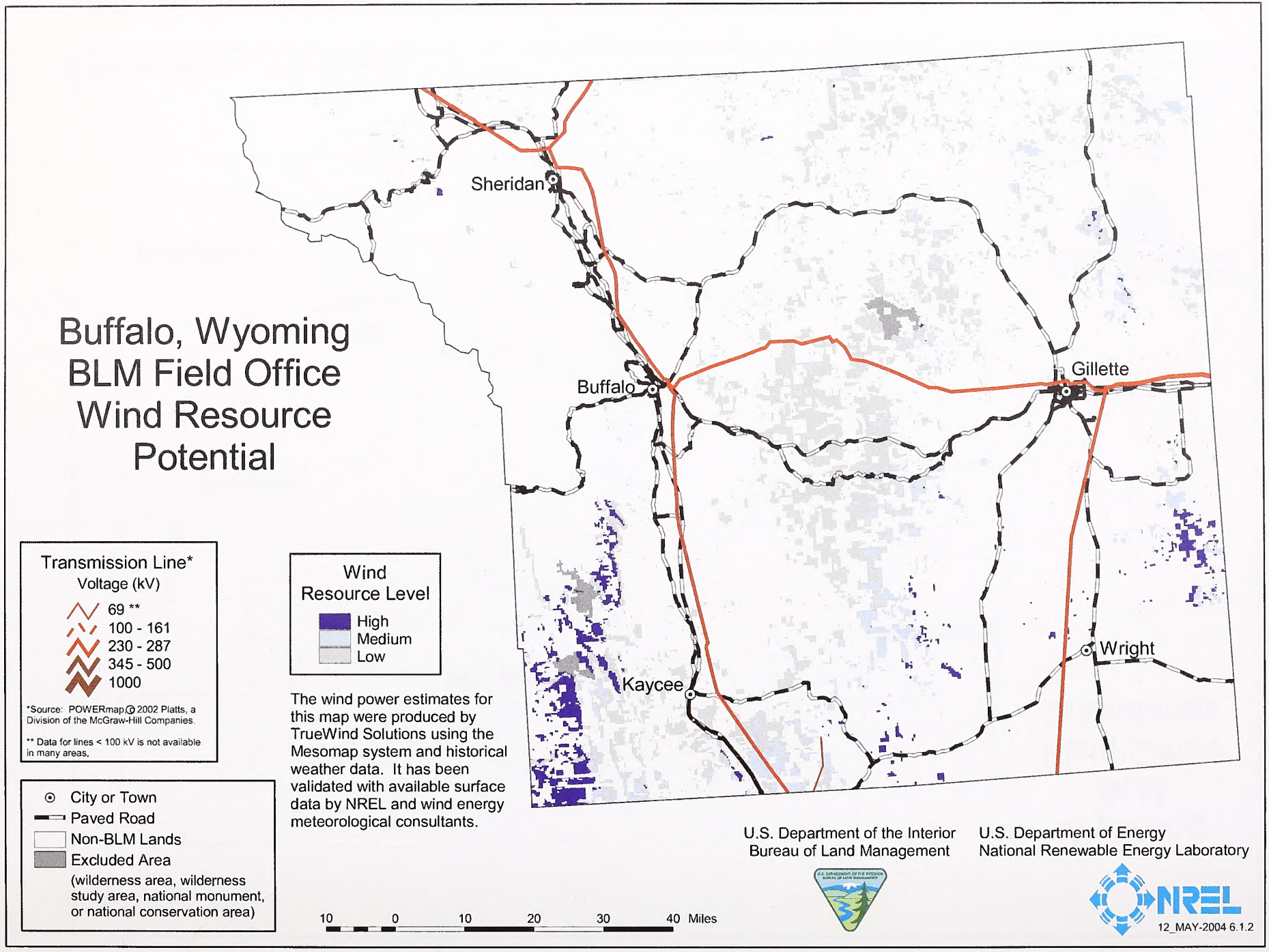
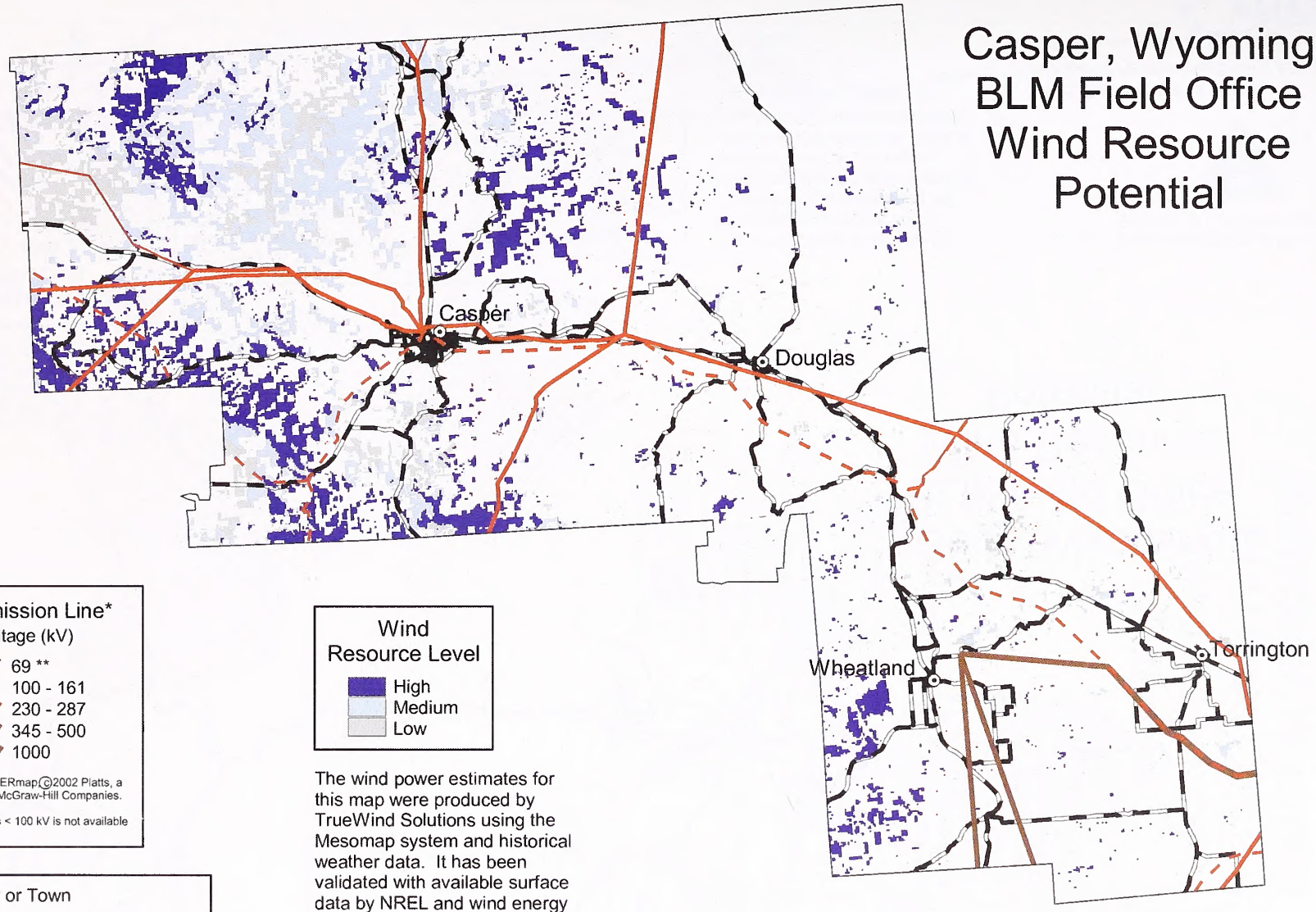


FIGURE B-13 Index Map Showing Locations of Field Office Boundaries in Wyoming


Buffalo, Wyoming
BLM Field Office
Wind Resource
Potential
Sheridan
Buffalo
Gillette
Wright
Kaycee
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap,© 2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
Wind
Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
10 0 10 20 30 40 Miles
U.S. Department of the Interior
Bureau of Land Management
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12_MAY-2004 6.1.2

Casper, Wyoming BLM Field Office Wind Resource Potential



Transmission Line*
Voltage (kV)
- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap©2002 Platts, a Division of the McGraw-Hill Companies.

** Data for lines < 100 kV is not available in many areas.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

Wind Resource Level
- High
- Medium
- Low

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

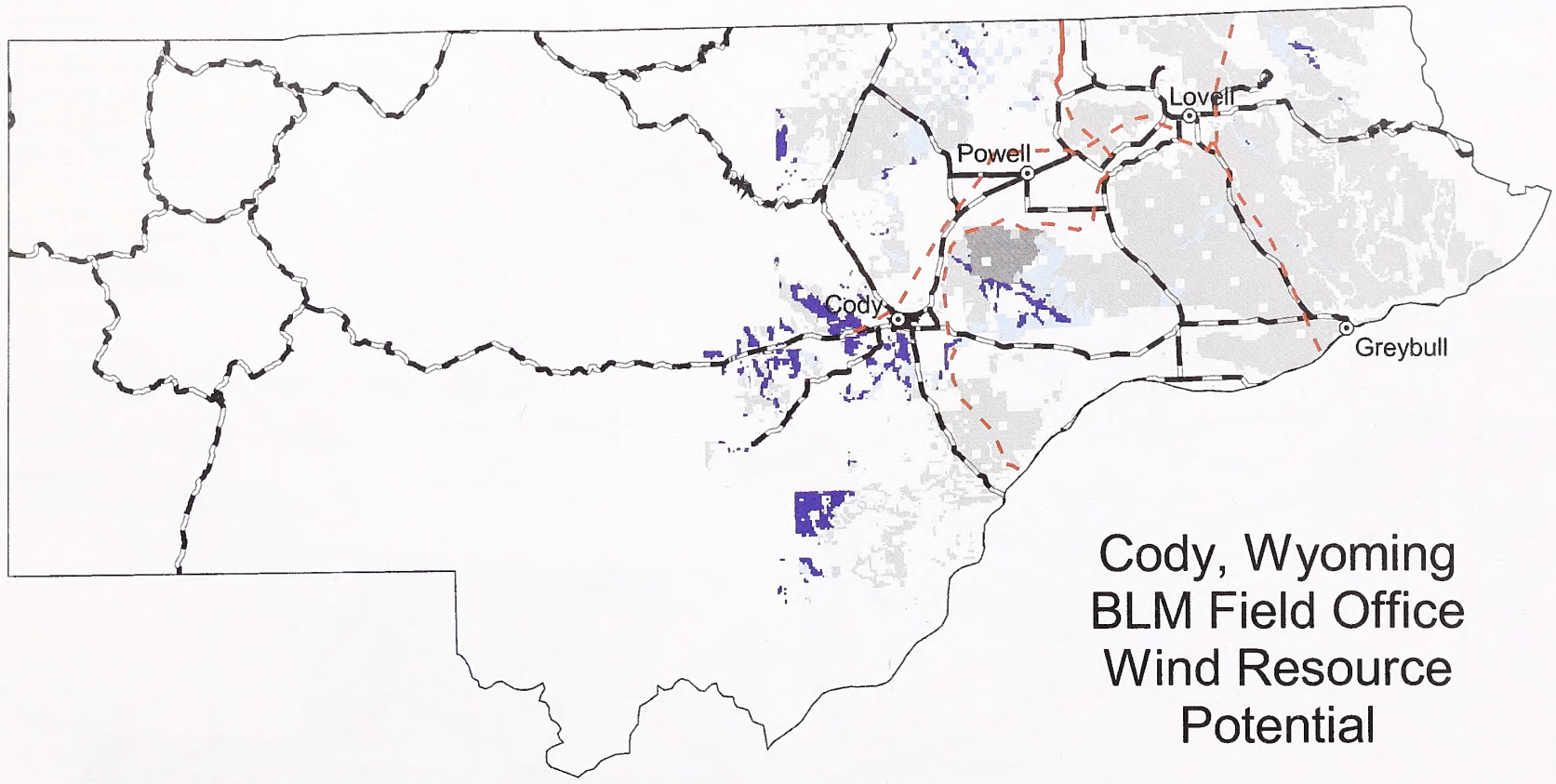
10 0 10 20 30 40 Miles

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Cody, Wyoming BLM Field Office Wind Resource Potential

Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000

*Source: POWERmap,©2002 Platts, a Division of the McGraw-Hill Companies.

** Data for lines < 100 kV is not available in many areas.

City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)

Wind Resource Level
High
Medium
Low

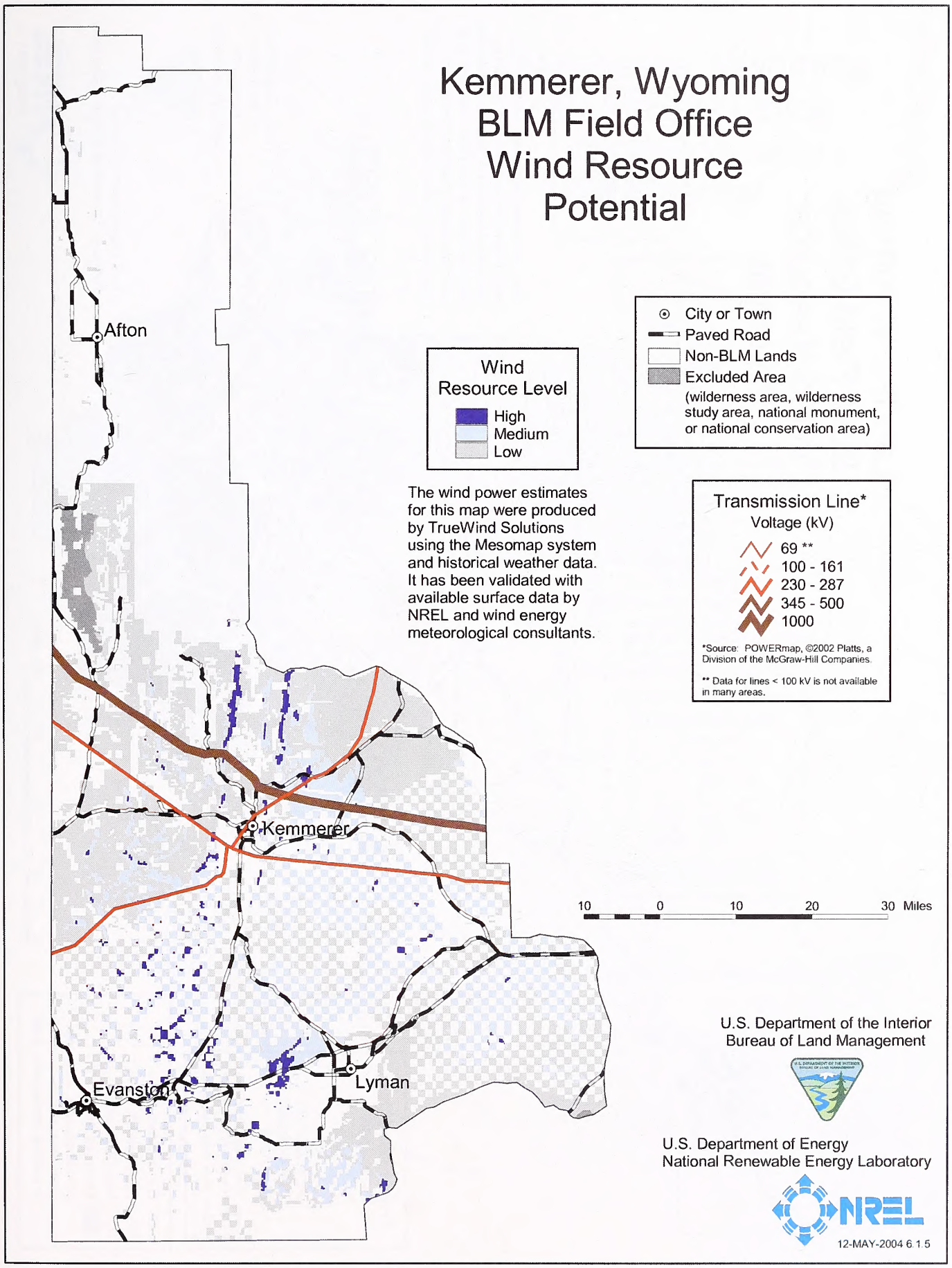
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

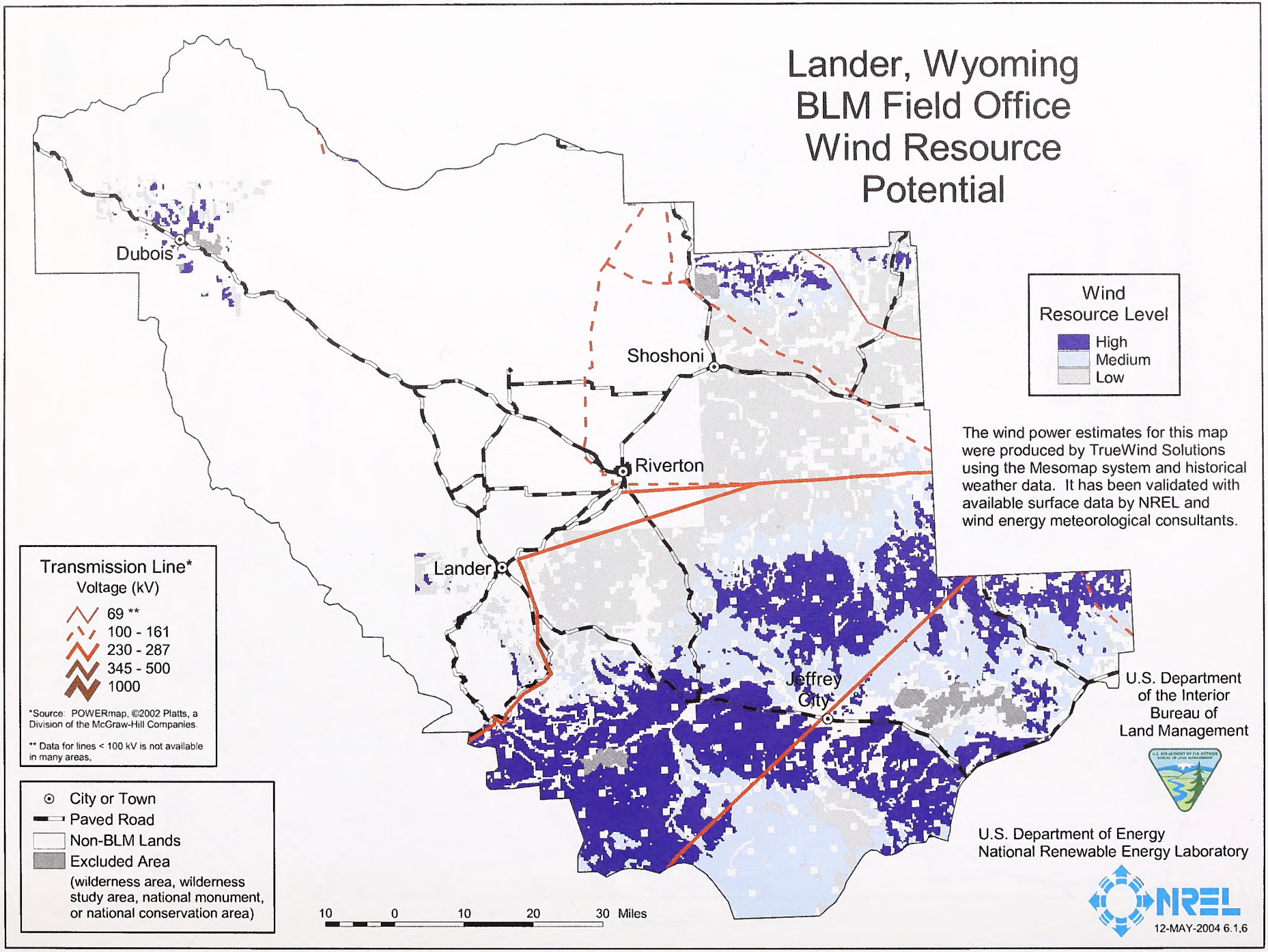
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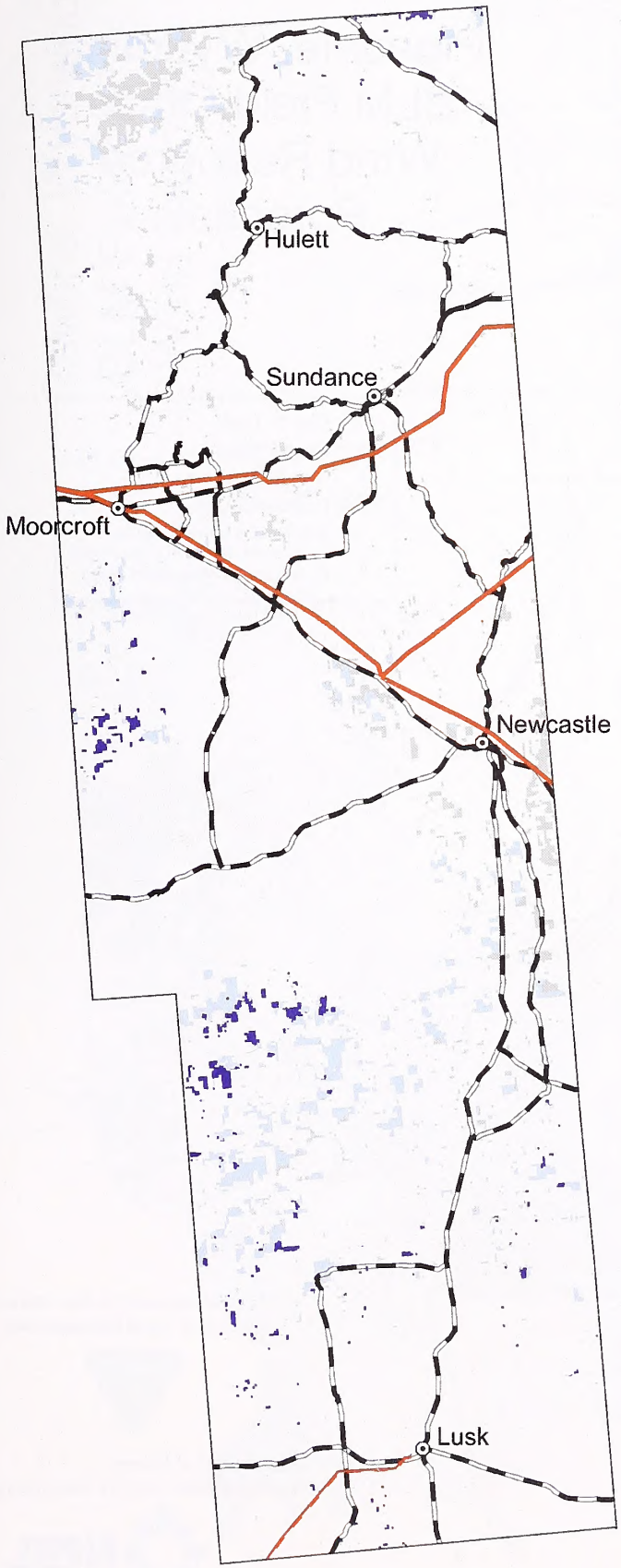
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NREL

10 0 10 20 30 Miles

12-MAY-2004 6.1.4


Kemmerer, Wyoming
BLM Field Office
Wind Resource
Potential
Afton
Kemmerer
Evanston
Lyman
Wind
Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
10 0 10 20 30 Miles
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U.S. Department of Energy
National Renewable Energy Laboratory
NREL
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Lander, Wyoming
BLM Field Office
Wind Resource
Potential
Dubois
Shoshoni
Riverton
Lander
Jeffrey City
Wind Resource Level
High
Medium
Low
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
10 0 10 20 30 Miles
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Newcastle, Wyoming BLM Field Office Wind Resource Potential

Wind Resource Level
- High
- Medium
- Low

The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

- City or Town
- Paved Road
- Non-BLM Lands
- Excluded Area (wilderness area, wilderness study area, national monument, or national conservation area)

Transmission Line*
Voltage (kV)
- 69 **
- 100 - 161
- 230 - 287
- 345 - 500
- 1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.

** Data for lines < 100 kV is not available in many areas.

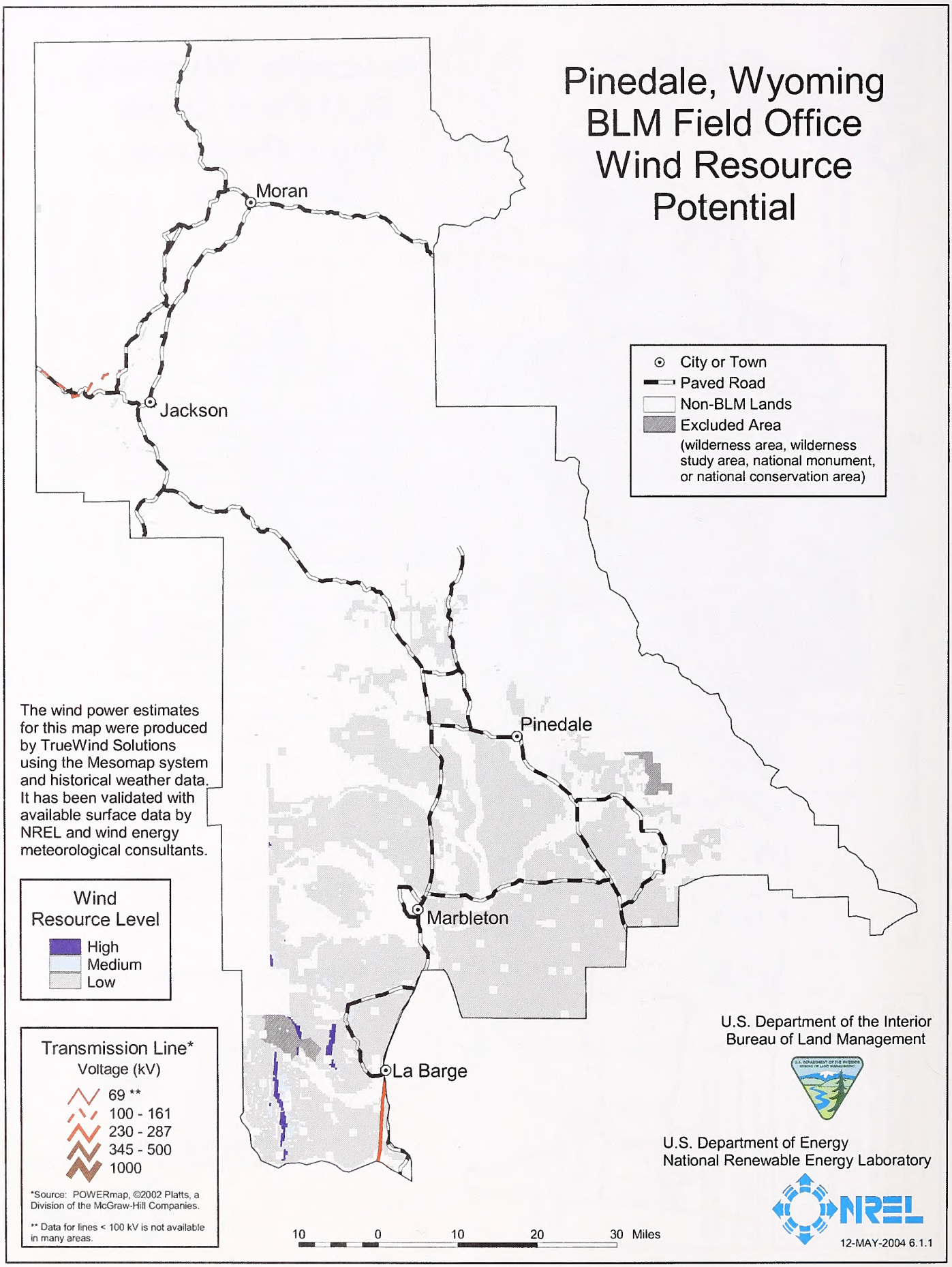
10 0 10 20 30 Miles

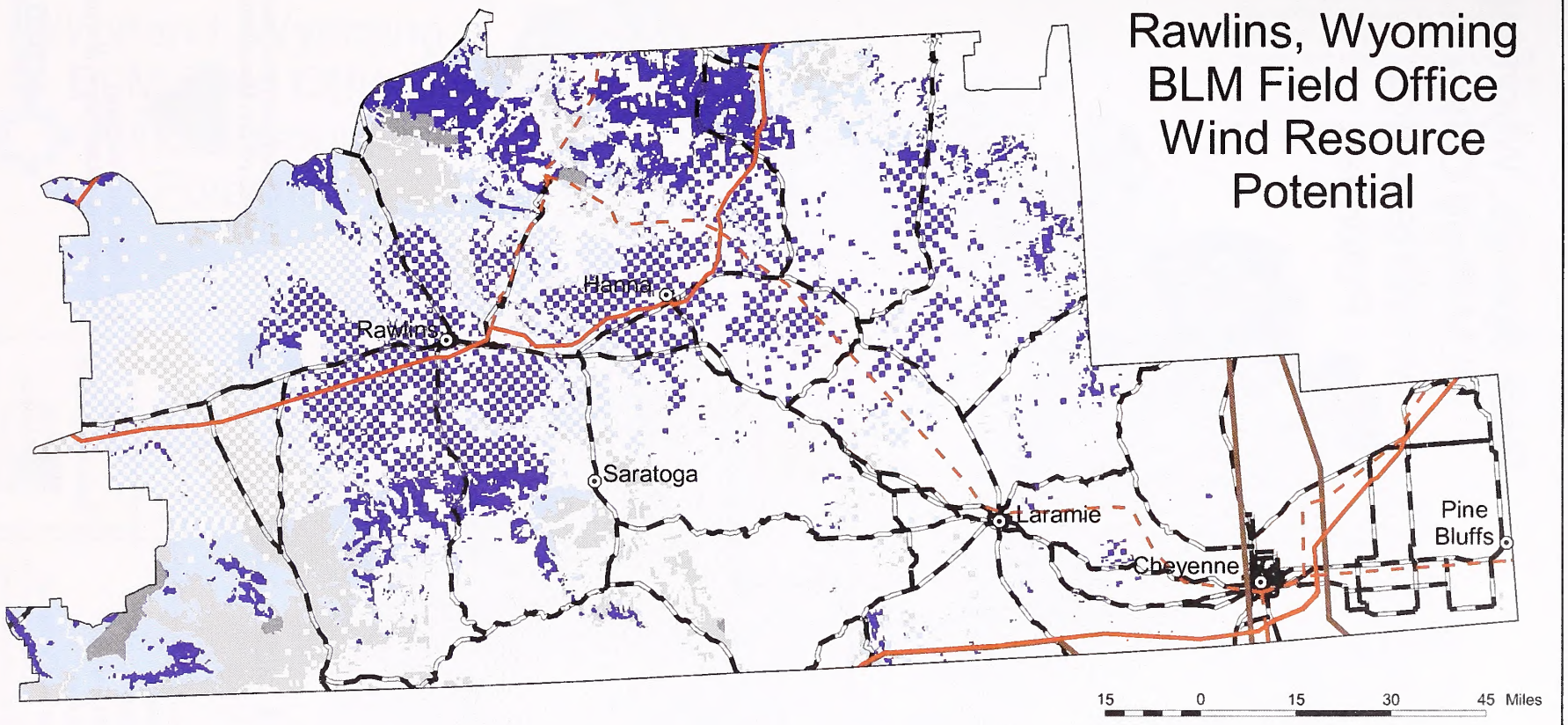
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U.S. Department of Energy
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Pinedale, Wyoming
BLM Field Office
Wind Resource
Potential
Moran
Jackson
Pinedale
Marbleton
La Barge
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Resource Level
High
Medium
Low
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
10 0 10 20 30 Miles
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U.S. Department of Energy
National Renewable Energy Laboratory
NREL
12-MAY-2004 6.1.1



Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000

*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.

** Data for lines < 100 kV is not available in many areas.

City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)

Wind Resource Level
High
Medium
Low

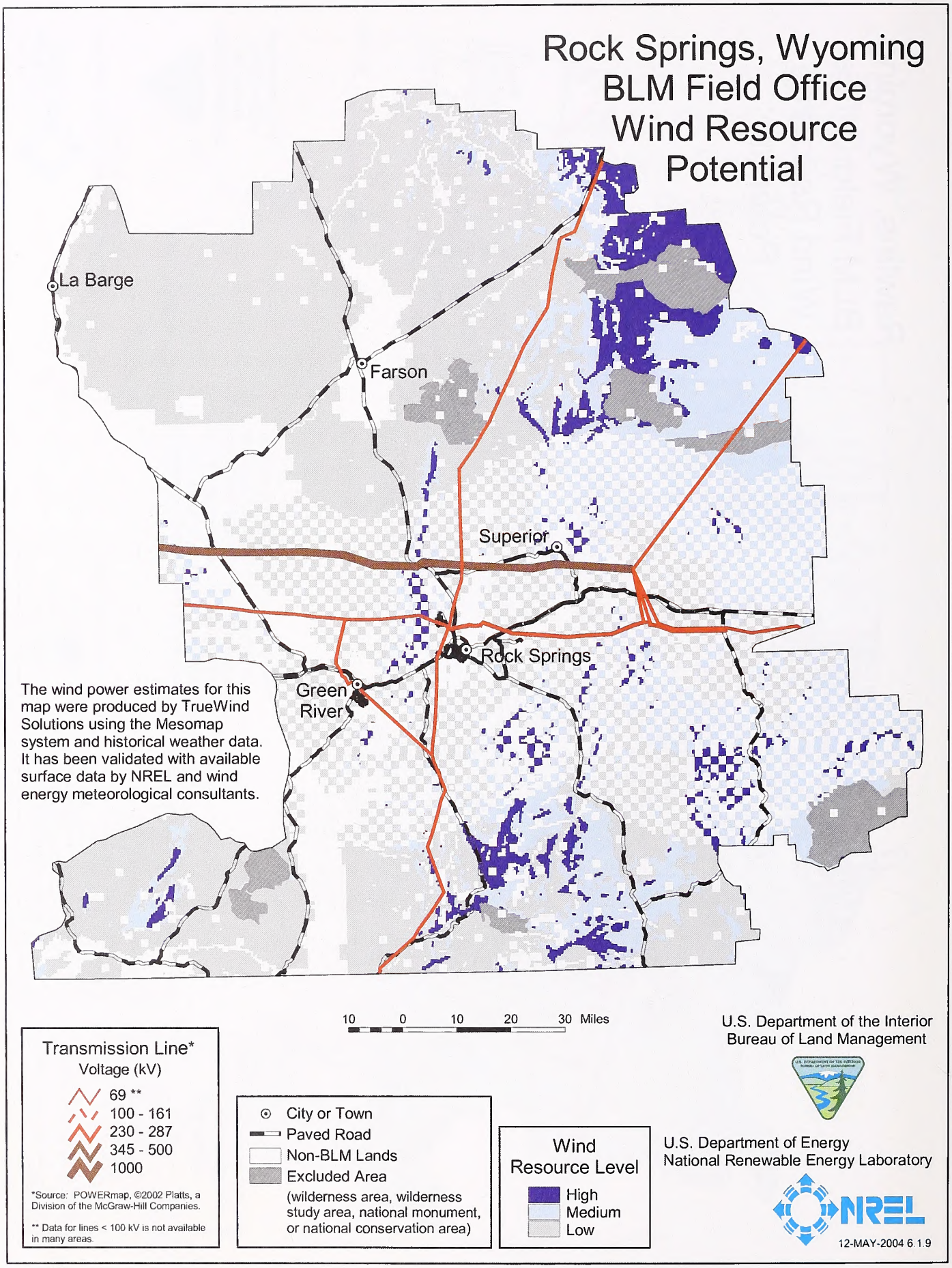
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

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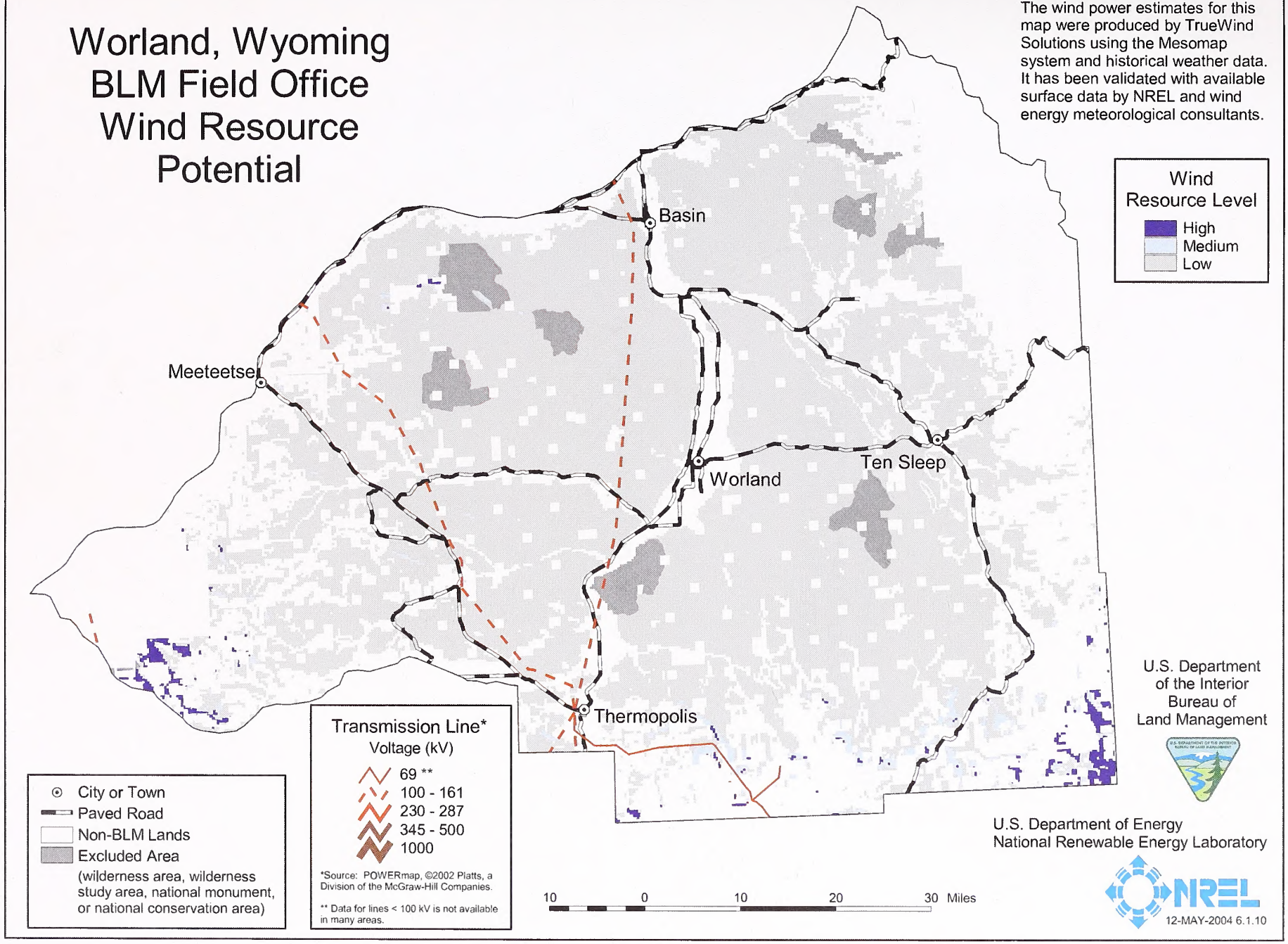
U.S. Department of Energy
National Renewable Energy Laboratory

NREL

12-MAY-2004 6.1.8


Rock Springs, Wyoming
BLM Field Office
Wind Resource
Potential
La Barge
Farson
Superior
Rock Springs
Green
River
The wind power estimates for this map were produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
10 0 10 20 30 Miles
Transmission Line*
Voltage (kV)
69 **
100 - 161
230 - 287
345 - 500
1000
*Source: POWERmap, ©2002 Platts, a Division of the McGraw-Hill Companies.
** Data for lines < 100 kV is not available in many areas.
City or Town
Paved Road
Non-BLM Lands
Excluded Area
(wilderness area, wilderness study area, national monument, or national conservation area)
Wind
Resource Level
High
Medium
Low
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Worland, Wyoming BLM Field Office Wind Resource Potential



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APPENDIX C:

PROPOSED LAND USE PLAN AMENDMENTS UNDER THE WIND ENERGY DEVELOPMENT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

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APPENDIX C:

PROPOSED LAND USE PLAN AMENDMENTS UNDER THE WIND ENERGY DEVELOPMENT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

Analyses conducted in this programmatic environmental impact statement (PEIS) support the amendment of specific land use plans where potentially developable wind resources are located. As discussed in Section 2.4, plans within the 11-state study area were reviewed to identify which ones should be amended under this PEIS. These plans are identified in Table 2.2.4-1. Proposed amendments include (1) adoption of the proposed programmatic policies and best management practices, and (2) identification of specific areas where wind energy development would not be allowed. By virtue of the proposed policy, wind energy development would be excluded on all National Landscape Conservation System (NLCS) lands and Areas of Critical Environmental Concern (ACECs). Although the Notice of Intent for this PEIS (Volume 68, page 201, of the *Federal Register*, October 17, 2003) indicated that the land use plan amendments would also identify some lands as suitable for competitive right-of-way (ROW) bidding processes, they were not identified for any of the plans included in Table 2.2.4-1. Interest in competitive ROW bidding processes currently is limited to two areas in California — the Palm Springs-South Coast Field Office and Ridgecrest Field Office — and would be addressed in local planning efforts.

Some plans within the 11-state study area were excluded from amendment under this PEIS for a variety of reasons, including (1) if developable wind resources (i.e., Class 3 or higher) are not present in the planning area, (2) if the plan was previously amended or revised to adequately address wind energy development, (3) if the plan currently is being amended or revised in a separate National Environmental Policy Act of 1969 (NEPA) review and that amendment or revision will address wind energy development, or (4) if some other reason(s) exist(s) to exclude the plan from amendment under this PEIS (e.g., a plan revision is scheduled in the foreseeable future).

None of the land use plans in Arizona or California are proposed for amendment under the PEIS. Ongoing and upcoming land use plan amendments being conducted outside the scope of this PEIS will address wind energy development in these states for areas where developable wind resources are present. Table C-1 provides information describing the proposed amendment change for each land use plan that is to be amended. The rationale for the proposed change also is provided.

TABLE C-1 Proposed Changes and Rationales for Land Use Plan Amendments[a]

Plan/Field Office	Proposed Change	Rationale
Colorado		
Royal Gorge RMP, Royal Gorge Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The current RMP does not address wind energy development, and the Field Office has received two recent inquiries about wind energy development. The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
San Luis RMP, includes La Jara, Saguache, and Del Norte Field Offices and the San Luis Valley Public Lands Center	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The current RMP does not address wind energy development, and the Field Office has received two recent inquiries about wind energy development. The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in the planning area.
Idaho		
Cascade RMP, Four Rivers Field Office	Wind energy development would be restricted from wildlife habitat where adverse effects could not be mitigated.	Restricted areas are not appropriate for wind energy development because of resource management conflicts.
	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The proposed BMPs may be appropriate for wind energy development in this planning area.
Challis RMP, Challis Field Office	Wind energy development would be restricted from wildlife habitat where adverse effects could not be mitigated.	Restricted areas are not appropriate for wind energy development because of resource management conflicts.
	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The proposed BMPs may be appropriate for wind energy development in this planning area.

TABLE C-1 (Cont.)

Plan/Field Office	Proposed Change	Rationale
Jarbidge RMP, Jarbidge Field Office	Wind energy development would be restricted from wildlife habitat where adverse effects could not be mitigated.	Restricted areas are not appropriate for wind energy development because of resource management conflicts.
	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The proposed BMPs may be appropriate for wind energy development in this planning area.
Kuna MFP, Four Rivers Field Office	Wind energy development would be restricted from wildlife habitat where adverse effects could not be mitigated.	Restricted areas are not appropriate for wind energy development because of resource management conflicts.
	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The proposed BMPs may be appropriate for wind energy development in this planning area.
Lemhi RMP, Salmon Field Office	Wind energy development would be restricted from wildlife habitat where adverse effects could not be mitigated.	Restricted areas are not appropriate for wind energy development because of resource management conflicts.
	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The proposed BMPs may be appropriate for wind energy development in this planning area.
Owyhee RMP, Owyhee Field Office	Wind energy development would be restricted from wildlife habitat where adverse effects could not be mitigated.	Restricted areas are not appropriate for wind energy development because of resource management conflicts.
	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The proposed BMPs may be appropriate for wind energy development in this planning area.

TABLE C-1 (Cont.)

Plan/Field Office	Proposed Change	Rationale
Twin Falls MFP, Burley Field Office	Wind energy development would be restricted from wildlife habitat where adverse effects could not be mitigated.	Restricted areas are not appropriate for wind energy development because of resource management conflicts.
	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Montana		
Billings RMP, Billings Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted with restrictions as indicated in the PEIS.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area. The Billings RMP is scheduled for revision in 2007; however, Billings also has an active wind testing and monitoring permit (MTM92391) with an effective date of September 28, 2003. If this potential project goes to full field development, it is doubtful that the RMP revision would be completed in time to address wind energy development on public lands. The current RMP does not address wind energy development.
Garnet RMP, Missoula Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
	RMP MA 9 would be identified as an exclusion area where wind energy and its associated development would be prohibited.	Wind energy development would be inconsistent with the BLM's management decisions and objectives.

TABLE C-1 (Cont.)

Plan/Field Office	Proposed Change	Rationale
Garnet RMP, Missoula Field Office (Cont.)	RMP MAs 1, 4, 10, and 11 would be identified as avoidance areas where wind energy and its associated development would be discouraged.	These areas contain important riparian areas; threatened and endangered species habitat; big game winter range; and/or recreation, and historic and cultural sites where wind energy development would be inconsistent with the BLM's management decisions and objectives.
Headwaters RMP, Butte Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Judith-Valley-Phillips RMP, Lewistown Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Judith-Valley-Phillips RMP, Malta Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
	Wind energy development would be excluded from large reservoirs/waterfowl complexes.	Development would be restricted within 2 mi (3 km) of these sites because of the potential for bird/tower strikes.
	Wind energy development would be excluded from Montana Air National Guard Training sites.	This area is in S. Phillips County and within the Hays Military Operations Area. Wind energy development would conflict with training missions.
	Wind energy development would be excluded from developed recreation sites.	Development within viewsheds would be restricted about 1 mi (2 km) unless topography can screen the project.
	Wind energy development would be excluded from backcountry byways.	Development should not be seen within the viewshed of the byway.

TABLE C-1 (Cont.)

Plan/Field Office	Proposed Change	Rationale
West Hi Line RMP, Lewiston Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
New Mexico		
Carlsbad RMP, Carlsbad Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program may be appropriate in some areas for wind energy development activities in this planning area.
	Wind energy development would be restricted in those areas along the face of the Guadalupe Mountains located in the western portion of the planning area and grassland areas in the northwestern portion of the planning area.	This area provides critical habitat for Kuenzlers cactus and Aplamado falcon. Wind energy development in this area would be inconsistent with the BLM's management decisions and objectives for the critical habitat.
	Wind energy development would be restricted in those areas within the viewshed of Carlsbad Caverns National Park.	Carlsbad Caverns National Park receives heavy tourist traffic throughout the year. Because of the significance of the park, wind energy development in the viewshed for the park would be inconsistent with the BLM's management decisions and objectives as well as those of the National Park Service.
	Wind energy development would be restricted in those areas that are within known cave/karst areas within the planning area.	Much of the known cave/karst areas have been designated as "high wind resource levels"; however, wind energy development in this area would have to be restricted because of the numerous cave/karst features in the area.
	Wind energy development would be restricted in those areas that are within the Guadalupe National Backcountry Byway and the Guadalupe Escarpment Scenic Area.	Any wind development in these areas would have a negative impact on the VRM ratings for these areas, which would be inconsistent with current BLM management decisions and objectives.

TABLE C-1 (Cont.)

Plan/Field Office	Proposed Change	Rationale
Carlsbad RMP, Carlsbad Field Office (Cont.)	Wind energy development would be restricted in designated Special Management Areas.	Wind development in these areas would be inconsistent with BLM management decisions and objectives.
Mimbres RMP, Las Cruces Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Roswell RMP, Roswell Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
White Sands RMP, Las Cruces Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Nevada		
Elko RMP, Elko Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Las Vegas RMP, Las Vegas Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Paradise-Denio MFP, Winnemucca Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.

TABLE C-1 (Cont.)

Plan/Field Office	Proposed Change	Rationale
Shoshone-Eureka RMP, Battle Mountain Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Sonoma-Gerlach MFP, Winnemucca Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Tonopah RMP, Battle Mountain Field Office, Tonopah Field Station	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Wells RMP, Elko Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Oregon		
Andrews/Steens RMP, Andrews/Steens Field Office[b]	Wind energy development would be restricted from ROW, realty use, and renewable energy avoidance and exclusion zones as identified in the RMP and the portion of the Steens Mountain CMPA in the planning area.	Wind energy development would be incompatible with the purposes and objectives of the special designations (ACECs, WSAs, RNAs, and ONAs) that were identified as avoidance and exclusion areas in the RMP. Although the RMP does not designate the portion of the Steens Mountain CMPA in the planning area as an avoidance/ exclusion zone, the restrictions on facility development contained in the language of the Steens Mountain CMPA exclude wind energy development in this area.
Brothers/LaPine RMP, Deschutes and Central Oregon Field Offices	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.

TABLE C-1 (Cont.)

Plan/Field Office	Proposed Change	Rationale
Coos Bay RMP, Coos Bay Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Eugene RMP, Eugene Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
John Day RMP, Central Oregon Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Medford RMP, Medford Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Salem RMP, Salem Field Office	BMPs and automatic avoidance/exclusion zones included in the proposed Wind Energy Development Program would be adopted.	The BMPs and automatic avoidance/exclusions zones included in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Southeast Oregon RMP, Malheur and Jordan Resource Areas	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Three Rivers RMP, Three Rivers Field Office	It would be clarified that wind energy development is allowable on a case-by-case basis in areas outside ROW and land use authorization avoidance and exclusion zones.	The RMP does not contain any explicit discussion on wind energy development, although the plan designates avoidance and exclusion areas for ROW and land use authorizations.

TABLE C-1 (Cont.)

Plan/Field Office	Proposed Change	Rationale
Three Rivers RMP, Three Rivers Field Office (Cont.)	Wind energy development would be restricted from ROW and land use authorization avoidance and exclusion zones identified in the RMP and the portion of the Steens Mountain CMPA in the planning area.	Wind energy development would be incompatible with the purposes and objectives of the special designations (ACECs, WSAs, RNA, and ONAs) that were identified as avoidance and exclusion areas in the RMP. Although the RMP does not designate the portion of the Steens Mountain CMPA in the planning area as an avoidance/exclusion zone, the restrictions on facility development contained in the language of the Steens Mountain CMPA exclude wind energy development in this area.
	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Two Rivers RMP, Deschutes and Central Oregon Field Offices	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Upper Deschutes RMP, Deschutes Field Office[c]	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Utah		
Cedar-Beaver-Garfield-Antimony RMP, Cedar City Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.

TABLE C-1 (Cont.)

Plan/Field Office	Proposed Change	Rationale
Escalante MFP, Kanab Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Paria MFP, Kanab Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Pinyon MFP, Cedar City Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Randolph MFP, Salt Lake Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
St. George RMP, St. George Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Vermillion MFP, Kanab Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Zion MFP, Kanab Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.

TABLE C-1 (Cont.)

Plan/Field Office	Proposed Change	Rationale
Washington		
Spokane RMP, Wenatchee and Border Field Offices	BMPs and automatic avoidance/exclusion zones included in the proposed Wind Energy Development Program would be adopted.	The BMPs and automatic avoidance/exclusion zones included in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Wyoming		
Buffalo RMP, Buffalo Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Cody RMP, Cody Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Grass Creek RMP, Worland Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Green River RMP, Rock Springs Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Lander RMP, Lander Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.

TABLE C-1 (Cont.)

Plan/Field Office	Proposed Change	Rationale
Newcastle RMP, Newcastle Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.
Washakie RMP, Worland Field Office	Programmatic policies and BMPs in the proposed Wind Energy Development Program would be adopted.	The programmatic policies and BMPs in the proposed Wind Energy Development Program are appropriate for wind energy development activities in this planning area.

[a] Abbreviations: ACEC = Area of Critical Environmental Concern; BMP = best management practice; CMPA = (Steens Mountain) Cooperative Management and Protection Area; MA = management area; MFP = Management Framework Plan; ONA = Outstanding National Area; RMP = Resource Management Plan; RNA = Research Natural Area; ROW = right-of-way; VRM = Visual Resource Management; WSA = Wilderness Study Area.

[b] The Andrews/Steens RMP is currently being revised; upon completion, it will replace the Andrews MFP and revise part of the Three Rivers RMP. The proposed amendments listed in this table will be applied to whatever plans are in existence at the time the Record of Decision (ROD) is issued for this PEIS.

[c] The Upper Deschutes RMP is currently being revised; upon completion, it will replace a portion of the Brothers/LaPine RMP. The proposed amendments listed in this table will be applied to whatever plans are in existence at the time the ROD is issued for this PEIS.

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APPENDIX D:

WIND ENERGY TECHNOLOGY OVERVIEW

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Modern wind energy technologies rely heavily on the very complex scientific discipline of fluid dynamics (which includes the study of the atmosphere) and the equally complex engineering discipline of aerodynamics. A comprehensive treatment of either of these disciplines is well beyond the scope of this programmatic environmental impact statement (PEIS). The discussions that follow are intended only to establish a basic understanding of wind technology and the factors that control its evolution. References are provided for those who wish to have a more detailed understanding of wind technology.

This appendix provides an overview of the fundamentals of wind energy and wind energy technologies, describes the major components of modern wind turbines, and introduces terms that are unique to the field of electric power generation using wind energy. Important site characteristics and critical engineering aspects of wind energy technologies are presented, and their respective influences on future development decisions are discussed.[1] An overview of the current state of wind energy technology and ongoing research and development (R&D) is provided. Descriptions of a typical wind energy project and the major actions associated with each phase of development — site monitoring and testing, construction, operation, and decommissioning — are presented in Chapter 3 of this PEIS.

D.1 IMPORTANT TERMS AND CONVENTIONS

Discussions in the following sections introduce important terms and conventions, some of which are unique to the wind energy industry. The terms and conventions are described in the text where they are first introduced. Additional details are provided in the glossary of this PEIS (Chapter 10).

D.2 WIND ENERGY

Wind represents the kinetic energy of the atmosphere. In simplest terms, wind is the movement of air in the earth's atmosphere relative to a fixed point on the earth's surface. The major initiator of that movement is the uneven heating of the earth's surface by solar radiation. The materials that compose the patchwork of the earth's surface (e.g., vegetation, exposed rock, snow/ice cover, and water) react differently to solar radiation, absorbing heat energy and reflecting some of that energy back into the atmosphere at different rates. The result is a nonequilibrium condition in which adjacent air masses have different heat energies and, as a result of adiabatic expansion or compression, different barometric pressures. Wind is one result

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[1] Wind farm developers and their investment capitalists must select among myriad options related to turbine design and site development and operation. Only those factors that have direct relationships to direct or cumulative impacting factors that are analyzed in this PEIS are discussed here.

of the atmosphere's attempt to normalize those differences and return to the lowest possible equilibrium state. The rotation of the earth around its axis initially causes a generally uniform global flow of air from west to east; however, many other factors add complexity to the dynamics of the earth's atmosphere. The text box on the next page has additional information on atmospheric motion.

D.3 EXTRACTING THE POWER OF THE WIND

The kinetic energy of wind is related to its velocity. This relationship is represented mathematically by the following equation:

$$P = \tfrac{1}{2} \times \rho \times A \times V^3 , \qquad \text{(D.1)}$$

where

P = wind power (W),

ρ = air density (typically 2.70 lb/m^3 [1.225 kg/m^3] at sea level and 59°F [15°C]),

A = cross-sectional area of the wind being measured (m^2), and

V = mean velocity of the wind within the measured cross section (m/s).

A careful examination of this power equation reveals the following important fundamental truths about wind energy. Both the air's density and the cross-sectional area of the wind being intercepted have a direct relationship to wind power. The air's density varies with temperature, elevation, and humidity, but, in all instances, the density remains relatively low. Thus, any changes to air density have a minimal effect on the wind's inherent power. Doubling the cross-sectional area of a wind front leads to a doubling of the intrinsic power. Most important to wind farmers is the fact that the wind's power is proportional to the cube of its average velocity. Thus, a doubling of the average or mean wind speed results in an eightfold increase in its power.

As a practical matter, wind energy technologists focus on the wind's "power density" or power per unit area of wind being intercepted, expressed in W/m^2. Simple manipulation of the above power equation allows power density to be calculated by using the following expression:

$$\text{Power density} = P/A = \tfrac{1}{2} \times \rho \times V^3. \qquad \text{(D.2)}$$

The height of the wind above the earth's surface also affects the average wind speed. Frictional drag and obstructions near the surface of the earth generally retard wind speed and induce a phenomenon known as wind shear (the change in a wind's speed with elevation). The rate at which wind speed increases with height varies on the basis of local conditions of the topography, terrain, and climate, with the greatest rates of increase observed over the roughest terrain. Unique local conditions notwithstanding, a reliable approximation is that wind speed increases approximately 10% with each doubling of height (Gipe 1995).

Understanding Atmospheric Motion

Wind represents the earth's atmosphere in motion. Understanding the development and progression of wind involves understanding the complex array of forces that constantly act upon the earth's atmosphere and cause its continuous motion. The velocity, direction, and variability of wind are products of those collective forces. The major forces at play include basic laws of thermodynamics, the force of the earth's gravity, frictional forces and obstructions imposed by the topography of the earth's surface, and the Coriolis effect caused by the earth's rotation. Thermodynamics governs the ways in which a given air mass behaves as it exchanges heat energy with its surroundings. Although the atmosphere's density is quite low, the gravitational forces of the earth nevertheless exert a constant downward force on the atmosphere that continuously affects its behavior.

It can be intuitively understood that the surface of the earth over which wind passes can also have some influence on wind, especially in the planetary boundary layer (the portion of the atmosphere immediately above the earth's surface). Topography can either increase or decrease wind speed in localized areas. Topography can also contribute to or induce wind shear (the rapid change of direction of wind with altitude). When other overriding forces are absent, topographic obstructions and friction at the earth's surface generally result in higher wind speeds at higher altitudes, with the highest wind speeds being achieved when all surface influences disappear. This wind is called the geostropic wind. The height or thickness of the planetary boundary layer varies over the surface of the earth (and actually changes slightly over the course of the day as a result of solar heating), reaching to thousands of feet in some locations. For the practical purpose of harvesting wind energy, the wind regime of greatest interest is contained completely within the boundary layer and, ideally, is composed largely of geostrophic wind.

The force commonly referred to as the Coriolis effect is more difficult to comprehend. Although it is easy to understand wind as being the motion of the atmosphere relative to one's point of observation on the surface of the earth, it is also important to recognize that one's point of observation, while it is fixed on the earth's surface, is not fixed in space, and it is itself moving as the result of both the earth's rotation and its orbit around the sun. The Coriolis effect is most easily defined as that apparent force on the wind that would not have otherwise occurred except for the earth's rotation and movement through space. It is manifested as a bending or redirection of the wind into circular patterns as air masses move from high-pressure to low-pressure areas. The magnitude of the Coriolis effect is a function of latitude. Winds directly above the earth's equator and moving in a direction parallel to the earth's axis of rotation experience very little in the way of a Coriolis effect. Winds occurring at other latitudes experience a Coriolis effect that is roughly proportional to the distance of that latitude from the equator. This fact can be easily understood by recognizing that any given point on the earth's surface along its equator is traveling at roughly 373 mph (600 km/h) around the earth's axis of rotation, while both the north and south poles have virtually no angular momentum.

Other characteristics of atmospheric motion that are of great practical significance to wind energy development are those factors that contribute to its variability over both time and geographic location. These factors include topography-induced variations, annual and seasonal wind speed variability, synoptic variations (resulting from or influenced by broad-area weather patterns and storm fronts), diurnal variations (reflecting changes in levels of solar radiation over a 24-hour cycle), turbulence (the uneven, chaotic motion of air), wind gusts, and extreme wind speeds. All such factors are critical to identifying ideal wind regimes and to designing wind turbines that can capture wind energy with the greatest efficiency while still withstanding the forces to which they will be exposed over their lifetimes. Since most of these forces exhibit their greatest influence on atmospheric motion in the planetary boundary layer (the portion of the atmosphere in which wind turbines normally operate), their influence on siting decisions and turbine design is substantial. While many of these variability factors can be intuitively understood, many others cannot. This uncertainty leads directly to the difficulties that now exist in accurately predicting weather. This uncertainty also greatly increases the complexity involved in selecting and developing the ideal wind farm.

Because wind flows not only more quickly but also more uniformly as the elevation from the earth's surface increases, the power contained in the wind is both greater and more easily extractable at higher elevations. Because turbulence decreases as the distance from surface obstructions increases, power actually increases faster with height than the relationship of power to the cube of the wind's speed would indicate. Thus, for example, a fivefold increase in height results in nearly a doubling of available wind power. To take advantage of this relationship, wind turbine developers pursue designs that not only allow the capture of the greatest cross-sectional area of wind but also allow the capture of wind at the highest practical elevation possible. There are trade-offs, however. Higher turbine elevations require more substantial support systems (both towers and their foundations) and substantially greater initial investments. Higher altitudes also subject the rotor and the nacelle, as well as the tower itself, to greater aerodynamic forces, which can require extensive design modifications and can shorten the expected operating lives of the tower and its components. Finally, operation and maintenance (O&M) activities can also be more complicated and costly with increases in the elevation of the rotor.

D.3.1 Characterizing Candidate Sites and Site Selection

The wind energy industry has adopted a convention by which annual average wind power densities and speeds are divided into seven power classes. It is also common practice to represent wind speed at a specified elevation above the land surface to allow comparative evaluations of sites within a given class to be made. To facilitate the identification of ideal wind regimes, the U.S. Department of Energy's (DOE's) National Renewable Energy Laboratory (NREL) has developed comprehensive wind maps for the United States that show the spatial distributions of these power classes. These maps were derived from meteorological data collected at thousands of locations. Figure D-1 shows the wind resource distribution map for the contiguous 48 states. (Power density maps have also been developed for Alaska and Hawaii. However, since lands administered by the Bureau of Land Management [BLM] in those states are outside the scope of this PEIS, maps for those two states are not displayed here.) A more detailed discussion on the distribution of ideal wind regimes and more detailed maps showing ideal wind regimes on BLM-administered lands and their locations relative to existing electric power transmission lines are provided in Appendix B. Developers using currently available wind turbine technologies have found that sites with wind power densities at Class 4 or higher represent economically viable sites for a wind farm.

These wind maps serve only as a preliminary screening tool for site selection. Developers must still investigate the properties of the wind regime at any candidate site in much greater detail before assigning a practical value to the site and deciding on a course of development. The principal limitation to the wind power distribution map displayed here is that it shows only the annualized average wind speeds and power densities. Two sites with identical annual average wind speeds and power densities may have arrived at those average values by entirely different paths. Sites whose average speeds and power densities are the product of widely varying instantaneous wind speeds over time are much less attractive than sites displaying lesser wind speed variations over time with few or no instances of excessive, potentially damaging wind speeds.

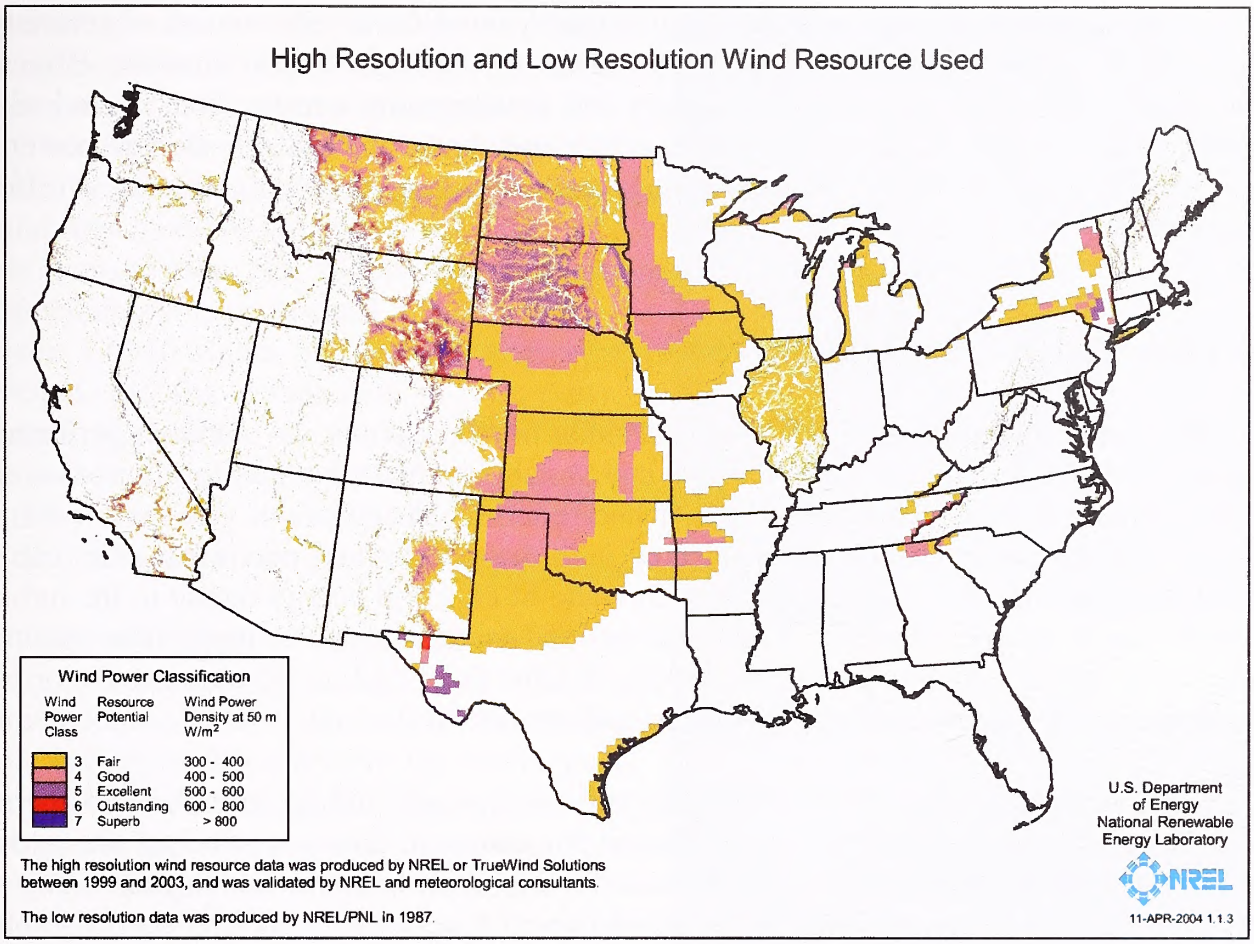


FIGURE D-1 Wind Resource Distribution Map for the 48 Contiguous United States (Source: EERE 2004b)

The developer must understand the time variability of the instantaneous wind speed. The ideal wind regime is one at which the instantaneous wind speed is near the upper limit of the operating range of commercially available wind turbines for the greatest percentage of time over the course of the year, thus maximizing annual energy production. (See Section D.5.3 for additional discussion on turbine operating ranges.) Therefore, the first step in any future wind farm development involves the collection of meteorological data (primarily wind speed and direction) at a potential candidate site for at least 1 year. For candidate sites in complex terrain or in areas with weather extremes, as many as 3 years of meteorological data may be necessary to support site development decisions. To realize their fullest value, the data must be collected at various locations within the site to support "micrositing" decisions (e.g., selecting the precise positioning of a wind turbine) and at various elevations to validate wind turbine decisions (e.g., selecting a turbine model and tower in which the rotor hub can be positioned at or near the elevation of maximum wind speed within its operating range and at a sufficiently high elevation so as to be above the chaotic and potentially damaging wind turbulence at or near the ground

surface).[2] When the wind regime is precisely mapped, wind farms can consist of a variety of turbine models operating at different hub elevations to reach maximum sitewide efficiency. However, this type of composition complicates site development, construction, operation, and maintenance and may also complicate the collection and conditioning of the electric power that is generated. The use of various turbine models is unlikely; however, placing turbines at different hub elevations is technically feasible.

D.3.2 Other Factors in Site Selection

Site selection primarily involves matching wind regimes to turbine performance characteristics. The wind's elevation profiles and variability over time and location, as well as the range of extant wind speeds, must be matched to turbine designs (and vice versa). All such efforts to find the perfect match are conducted with the intention of maximizing the capacity factor of each turbine. This capacity factor is the ratio of expected energy output to the turbine's maximum rated power capacity, expressed as an annualized percentage (see additional discussion on capacity factors in Section D.5.3). A wind farm's expected capacity factor is the single greatest influence on the farm's return on investment (ROI).

Obviously, selecting a location with the highest average wind speed within the operating range of the proposed wind turbine for the greatest percentage of time is a principal site selection objective. In practice, many other circumstantial factors, such as transmission access and road access, substantially affect the costs of site development and O&M; therefore, they also play a key role in site selection.

D.4 WIND TURBINE TECHNOLOGIES

The centuries-old history of efforts to harvest wind energy is fascinating, and an extensive discussion is beyond the scope of this PEIS. However, many excellent sources exist, including Gipe (1995), Hau (2000), Burton et al. (2001), Manwell et al. (2002), and Wilson (1994) and the references therein, as well as Web sites maintained by the DOE Office of Energy Efficiency and Renewable Energy (EERE 2004a), NREL (2004a), Sandia National Laboratories (2004a), the National Wind Coordinating Committee (NWCC 2004), and the American Wind Energy Association (AWEA 2004c).

Sailing ships probably represent the earliest attempt to harness the wind. Windmills, the most familiar wind technology, have been used for myriad applications, most commonly to grind grain and pump water and crude oil. There is speculation that the earliest windmills went into service more than 3,000 years ago. More reliable historical documentation dates the earliest use of windmills to 200 B.C. in Persia (now Iraq) (Sandia National Laboratories 2004a). There is

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[2] Although actual measurements of wind profiles at candidate sites are preferred, statistical methods can be utilized to extrapolate wind data from one site to nearby sites. An exhaustive discussion of these statistical methods is beyond the scope of this PEIS; additional information can be obtained from appropriate engineering texts (e.g., Burton et al. 2001; Manwell et al. 2002).

also evidence that windmills may have been used much earlier in China to drain rice fields, but the earliest dates of service are unclear. The use of windmills to generate electricity began in the late 19th century to provide electric power in rural areas, before the advent of far-ranging power transmission and distribution systems. Many windmills used in rural areas of Europe and the United States to pump water were converted for the production of electricity. Windmills such as the one shown in Figure D-2 were used to generate small amounts of electricity, normally to satisfy the demand for electric power in the immediate vicinity.



FIGURE D-2 Great Plains Windmill (Source: EERE 2004a)

Windmills are the progenitors of the modern wind turbine.[3] In fact, they share a common fundamental function: converting the kinetic energy of the wind into the mechanical energy of a rotating shaft. Throughout the development and evolution of the windmill, a variety of designs have been explored. The evolution of wind turbine design has followed a similar path. The earliest windmills had their axis of rotation oriented vertically, and vertical-axis wind turbines (VAWTs) were also developed. Later-model windmills have their axis of rotation in the horizontal position, and the analogous horizontal-axis wind turbines (HAWTs) also evolved. Although the orientation of the rotational axis defines the two primary design categories of wind turbines, many variations exist within each category.

Early sailing ships and the earliest windmills utilized the principle of "aerodynamic drag" to capture wind energy. Applying this principle involves installing an obstruction in the path of the wind. Depending on how this obstruction is oriented and what it is connected to, the force of the wind striking it can cause work to be performed (e.g., propelling a square-rigged sailing ship through the water). The common instrument for measuring wind speed, the cup anemometer, is an example of a present technology that still utilizes aerodynamic drag. Machines utilizing aerodynamic drag are easy to construct, and they make few design or operational demands. However, despite the relative simplicity of aerodynamic drag machines, their overall efficiency is generally low.

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[3] For this discussion, a wind turbine is defined as any device operated expressly for generating electricity, regardless of whether that electricity is utilized locally or introduced into power transmission and/or distribution systems.

No modern wind turbine operates on the principle of aerodynamic drag; instead, "aerodynamic lift" is utilized. When this principle is employed, the wind turbine's blades do not obstruct the wind; rather, they direct its flow. The cross-sectional shape of all modern wind turbine blades is that of an "airfoil." These blades are similar in shape and purpose to an airplane wing. Wind flowing around an airfoil creates two different regions of pressure: a low-pressure region on the convex or "suction" side of the airfoil, and a higher-pressure region on its concave or "pressure" side. The atmosphere's attempt to return to pressure equilibrium creates the phenomenon of aerodynamic lift. However, whereas an airplane's airfoils are oriented in such a way that aerodynamic lift helps the plane defy the laws of gravity (i.e., air pressure is lower above the wing than below it, causing the wing to "lift"), the orientation of a wind turbine's blades relative to incident wind converts aerodynamic lifting forces into the rotation of the blades around an axis parallel to the direction of the wind.[4] Wind turbines utilizing aerodynamic lift can have power efficiencies up to 50 times greater than the efficiencies of turbines operating on aerodynamic drag (Wilson 1994).

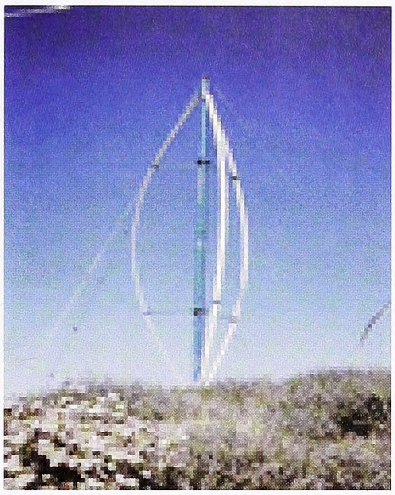
As noted previously, wind turbines have been developed with their axis of rotation in both the vertical orientation and the horizontal orientation. The VAWT traces its ancestry farther back in time than does the HAWT, to as early as 200 B.C. (Sandia National Laboratories 2004b). Modern VAWTs are variations of a design first introduced by French scientist Georges Darrieus around 1920. Figure D-3 shows examples of a commercial VAWT in California and an experimental VAWT currently operating at a DOE test facility in Texas.

In theory, both VAWTs and HAWTs should be able to capture the wind's energy by means of the principle of aerodynamic lift. However, VAWTs have a number of practical advantages. Because their blades are always perpendicular to the prevailing wind, they do not need to be reorientated when the wind direction changes in order to operate at their maximum efficiency. Thus, both their design and the complexity of their required operational controls are simplified. They are generally easier to erect than HAWTs and can have serviceable components located at or near ground level, thereby greatly simplifying their O&M. However, some of those same design characteristics contribute to the VAWT's intrinsic limitations. Many VAWT designs are not "free-wheeling" and must use an external energy source to start their rotation. Many also have limited wind speed operating ranges. VAWTs also have certain design limitations with respect to their maximum practical height.

Most important to their commercial application, however, is blade reliability and working life. VAWT blades must pass through the "wind shadow" or wake of their rotational axis, which also serves as the machine's primary support. This region typically exhibits a good deal of turbulence, which not only reduces power capture efficiencies but also subjects the blades to forces that are different and opposite to those that they experience when they are upwind of the center support; thus, significant engineering issues, such as fatigue, are introduced. Considerable research continues even today on how to overcome the intrinsic shortcomings of VAWTs, and VAWTs are being used as test platforms to generally advance the understanding of wind turbine

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4 Empirical studies have shown that the greatest turbine efficiencies are realized when the turbine rotor's axis of rotation is tilted slightly from the horizontal.



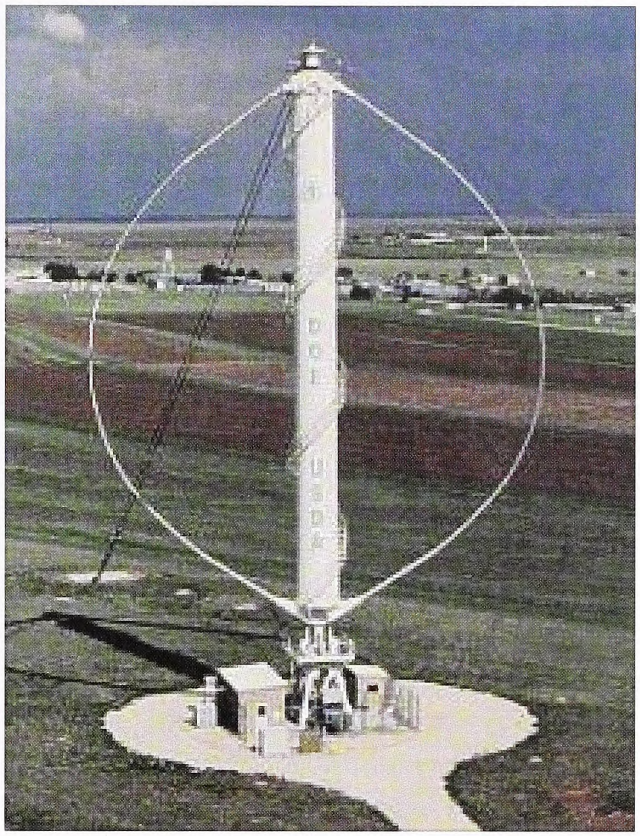


FIGURE D-3 Examples of VAWTs (Left: FloWind Corporation VAWT at Tehachapi, California. Photo credit: R. Thresher. Source: Photo #04688, NREL 2004b. Right: Darrieus-design VAWT operated as a wind energy technology test bed by Sandia National Laboratories at the U.S. Department of Agriculture research station at Bushland, Texas; 138 ft (42 m) high, 112 ft (34 m) in diameter. Photo credit: Sandia National Laboratories. Source: Photo #01671, NREL 2004b.)

technology. DOE's Sandia National Laboratories play a key role in this effort. However, only a few commercial wind farms that utilize VAWTs have ever been developed, and none are anticipated in the foreseeable future. Wind farms at Tehachapi Pass in California; Pincher Creek in Alberta, Canada; and Cap-Chat in Quebec, Canada, utilize or have utilized VAWTs. The leading manufacturer of commercial VAWTs, FloWind Corporation, is no longer in business. No VAWTs have ever gone into commercial service in Europe (Gipe 1995). Therefore, it is likely that HAWTs will continue to dominate the commercial market in the foreseeable future. Additional discussion of VAWT technology is therefore unnecessary for purposes of this PEIS.

In recent years, HAWTs have become the predominant technology used in commercial wind farms; thus, they are the focus of discussion in this PEIS. Figure D-4 shows an example of a typical front-facing HAWT. Within this category, Manwell et al. (2002) identified the following significant design variants: front-facing or rear-facing rotors and blades, rigid or teetering hubs, rotor rotation controlled by pitch or stall, number of blades (usually two or three), and free or controlled yaw motion. The majority of these design characteristics influence the

overall performance of a turbine, but most have little or no influence on the environmental impacts of an operating turbine and thus are not discussed in further detail.

D.5 IMPORTANT CONCEPTS OF MODERN HAWT OPERATION

Figure D-5 shows the major components of a HAWT. As noted previously, many factors influence the design and performance of modern wind turbines. This section focuses on the aspects of wind turbine design and operation that can have direct and/or cumulative environmental impacts. Also discussed here is the spatial arrangement of wind turbines on a wind farm, which can also result in environmental impacts.



FIGURE D-4 Typical Front-Facing or Upwind HAWT (GE's 3.6-MW prototype wind turbine is an example of a front-facing HAWT. It is one of the largest HAWTs in existence, with a rotor diameter of 341 ft [104 m], giving a swept area of the blades of 91,432 ft^2 [8,495 m^2]. Rotor speed is variable between 8.5 and 15.3 rpm. The tower is constructed of concrete [lower portion] and tubular steel. Here, the turbine faces into the wind, which enters from the left. Sources: Photo adapted from EERE 2004c. Turbine specifications available from GE 2004.)

D.5.1 Power Coefficients

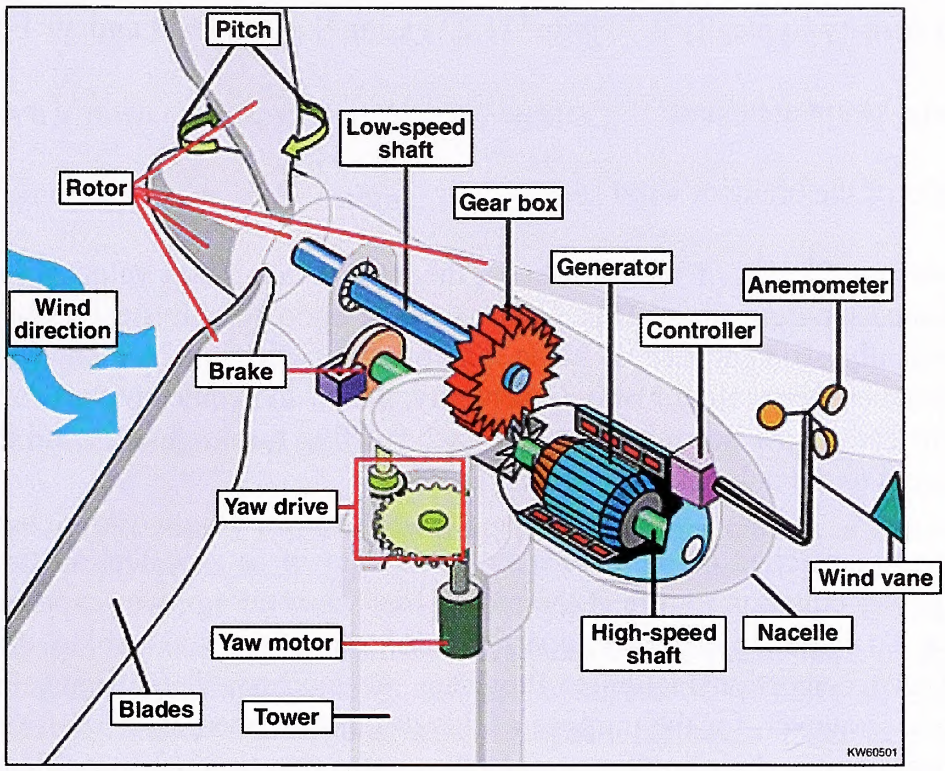
Intercepting the greatest practical cross-sectional area of wind creates the opportunity for capturing the greatest amount of energy; therefore, the primary design focus is on the rotor, which is the part of the turbine that actually extracts the wind's energy. No mechanical device, including the wind turbine, is 100% efficient. The practical efficiency of a wind turbine is usually represented as its power coefficient, C_p, defined as that fraction of the wind power that may be captured by the turbine and converted to mechanical work (and, subsequently, electricity). The power coefficient of a wind turbine is almost entirely a function of the rotor's efficiency. The power coefficient is represented by the following expression:

$$P = \tfrac{1}{2} \times C_p \times \rho \times A \times V^3, \qquad \text{(D.3)}$$

where

P = power output of the turbine,

C_p = power coefficient of the rotor,



Anemometer: Measures the wind speed and transmits wind speed data to the controller.

Blades: Most turbines have either two or three blades. Wind blowing over the blades causes the blades to "lift" and rotate. Front-facing turbines normally have three blades.

Brake: A disc brake, which can be applied mechanically, electrically, or hydraulically to stop the rotor in emergencies.

Controller: The controller starts the machine at wind speeds of about 8 to 16 mph (13 to 26 km/h) and shuts off the machine at about 65 mph (105 km/h). Turbines cannot operate at wind speeds above about 65 mph (105 km/h) because their generators could overheat.

Gear box: Gears connect the low-speed shaft to the high-speed shaft and increase the rotational speeds from about 30 to 60 rotations per minute (rpm) to about 1,200 to 1,500 rpm, the rotational speed required by most generators to produce electricity. The gear box is a costly (and heavy) part of the wind turbine, so engineers are exploring "direct-drive" generators that operate at lower rotational speeds and do not need gear boxes.

Generator: Usually an off-the-shelf induction generator that produces 60-cycle alternating current (ac) electricity.

High-speed shaft: Drives the generator.

Low-speed shaft: The rotor turns the low-speed shaft at about 30 to 60 rpm.

Nacelle: The rotor attaches to the nacelle, which sits atop the tower and includes the gear box, low-speed and high-speed shafts, generator, controller, and brake. A cover protects the components inside the nacelle. Some nacelles are large enough for a technician to stand inside while working.

Pitch: Blades are turned, or pitched, out of the wind to keep the rotor from turning in winds that are too high or too low to produce electricity.

Rotor: The blades and the hub together are called the rotor.

Tower: Towers are made from tubular steel (shown here) or steel lattice. Some taller towers may incorporate concrete over the lower portions of their height. Because wind speed increases with height, taller towers enable turbines to capture more energy and generate more electricity.

Wind direction: This is an "upwind" turbine, so-called because it operates facing into the wind. Other turbines are designed to run "downwind," facing away from the wind.

Wind vane: Measures wind direction and communicates with the yaw drive to orient the turbine properly with respect to the wind.

Yaw drive: Upwind turbines face into the wind; the yaw drive is used to keep the rotor facing into the wind as the wind direction changes. Downwind turbines do not require a yaw drive, since the wind blows the rotor downwind.

Yaw motor: Powers the yaw drive.

FIGURE D-5 Major Components of a Modern HAWT (Source: EERE 2004c)

ρ = air density (typically 2.70 lb/m^3 [1.225 kg/m^3] at sea level and 59°F [15°C]),

A = rotor-swept area, and

V^3 = cube of the incident wind speed.

The power coefficient of the rotor has a theoretical maximum value of 0.593, called the Betz limit or Lancaster-Betz limit. This value is based upon the physical reality that even the most aerodynamically efficient turbine blade disrupts the airflow of incident wind, even before the wind front reaches the rotating blade. In actuality, the air molecules within the cross-sectional area swept by the rotor slow down as they approach rotating turbine blades and thus lose kinetic energy proportional to the cube of that velocity loss.[5]

The power coefficient of the rotor can be thought of as a correction factor, introduced into the above power equation to reflect the reality that the rotor's power-capturing efficiency is less than perfect. To calculate the power coefficient of the entire wind turbine, one simply has to introduce additional correction factors to represent the mechanical inefficiencies of the entire turbine drivetrain. However, for the purpose of this discussion, the power coefficient of the rotor is the source of greatest turbine inefficiency to the extent that drivetrain inefficiencies need not be discussed in detail.

A comparison of the turbine efficiency equation above with the equation presented in Section D.3, which represents the power inherent in the wind, leads one to fully appreciate how energy is produced by wind turbines. The Betz limit actually reflects the impossibility of extracting all the energy from the wind. Because the theoretical limit of rotor efficiency is always considerably less than 100%, the power produced by a wind turbine is always less than the power contained in the wind cross section that the turbine is intercepting. And because the rotor's efficiency is the major contributor to the overall turbine efficiency, rotor design considerations are of paramount importance.

D.5.2 Turbine Power Curves

The graphical representation of a turbine's electric power output as a function of incident wind speed is known as the turbine's power curve. At a fixed rotor speed, the power production of a wind turbine is defined by the following equation:

$$P_{el} = c_p \times \rho/2 \times (v_w)^3 \times A \,, \qquad \text{(D.4)}$$

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5 The Betz limit is named after Albert Betz, the German dynamicist who first identified and defined the phenomenon. A more detailed discussion of the influence of turbine blades on airflow and the derivation of the Betz limit is provided in Burton et al. (2001).

where

P_{el} = electric power (expressed in W, kW, or MW),

c_p = power coefficient of the turbine,

ρ = air density (kg/m^3),

v_w = wind speed (m/s), and

A = swept area of the rotor (m^2).

Turbine manufacturers routinely use the power curve as a representation of their wind turbine's official certificate of performance.

Certain design features can have minor influences on the exact shape of the power curve; however, these influences notwithstanding, the power curves of virtually all commercial wind turbines are strikingly similar. As incident wind speed increases from zero to the "cut-in velocity," the net power extracted from the wind becomes greater than that which is necessary to overcome the mechanical drag of the turbine's drivetrain, and the excess power is used to begin producing usable electric power. With increasing wind speed, power production increases rapidly until the "rated velocity" is reached. At this wind speed, the turbine has reached its maximum electric power production capability. Power production continues at this maximum level with further increases in wind speed until the "cut-out velocity" is reached. At the cut-out velocity, the wind's energy is so great that it can cause mechanical damage to major turbine components. To prevent such damage, designers introduce various controls (such as pitch and stall control on the rotor, mechanical braking of the rotor shaft, and clutching mechanisms on the rotor shaft) that can decouple the rotor from the remainder of the turbine drivetrain.[6] With the application of such controls, the electric power production drops precipitously to zero, and the turbine effectively becomes nonfunctional as a power source. The range of wind velocities over which the turbine can produce electricity is referred to as its operating range; however, the maximum electric power production (i.e., the turbine's nameplate rating) is achieved only at the upper end of the operating range. At incident wind speeds between the cut-in velocity and the rated velocity, power production is well below the nameplate rating. In general, commercial wind turbines have operating ranges between 2.5 and 25 m/s. (Table D-2 in Section D.6, which provides commercial wind industry profiles, has examples of operating ranges.)

A turbine's power output can be derived solely from engineering calculations. However, because the power curve represents the manufacturer's guarantee of a turbine's performance, theoretical calculations are also carefully validated with real-world measurements. To overcome myriad real-world variables that can affect power production, such empirical verifications of power output are based on the statistical evaluation of a large number of measurements.

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6 In practice, such controls can be applied at any point throughout the operating range of the turbine to maintain the quality of electric power being produced and to overcome the real-world variability in incident wind energy over time.

Hau indicates that measurements averaged over a minimum of 10 minutes are usually sufficient to account for the time variability of operating conditions (Hau 2000).

D.5.3 Capacity Factors

Although the power curve is an accurate measure of the turbine's ability to generate electricity from incident wind, it does not adequately describe expectations of real-world power production. Overlaying the relevant characteristics of a given wind regime (most importantly, the percentage of time the incident wind is at the uppermost portion of the operating range) and introducing additional correction factors that reflect the turbine's technical availability (i.e., periods when the turbine is fully functional and not down for maintenance or repairs)[7] yield the capacity factor, the most realistic and reliable prediction of the energy yield for a given candidate site. Capacity factors are dimensionless, expressed as a ratio in which the turbine's annual predicted energy production is divided by the energy it would produce if it operated at its nameplate rating continuously. Capacity factors are normally represented as annualized values to account for seasonal variations in wind regimes. In practice, the most efficient wind farms exhibit individual turbine capacity factors of 30 to 35% (EPRI 2001; DOE/TVA/EPRI 2003; Robichaud 2004). However, capacity factors as high as 45% have been observed (Manwell et al. 2002; EPRI 2001; McGowan and Conners 2000). Capacity factors of at least 25% are considered minimally necessary for a site to be considered economically viable (McGowan and Conners 2000).

Because it is rooted in the real world, the capacity factor becomes a much more valuable tool for supporting decisions about wind farm development than the turbine's power curve alone. The ideal site from a power production perspective is one that yields the highest capacity factor for each of the turbines. That being said, however, it is important to also recognize that power-producing potential, although important, is not the exclusive basis for site development decisions. Many other factors, including ease of site access, access to transmission lines, site development costs, the absence of sensitive ecosystems, and market price for energy, are always also considered in site selection decisions. Thus, it is often the case that the sites with the ideal wind regimes yielding the highest predicted capacity factors are not necessarily assigned the highest priority for development.

D.5.4 Rotor Tip Speed and Tip Speed Ratio

The rotor tip speed is the tangential velocity of the very end of the blade of a rotating rotor (i.e., the speed at which the tip of the blade moves around the circumference of the swept area of the rotor). Early wind turbine designs sought to match the rotor speed with the rotational speed requirements of the electric generator's rotor.[8] However, modern designs utilizing more

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7 Hau (2000) cites studies from Denmark and Germany that support the claim that annualized availabilities of modern-day wind turbines can approach 98%.

8 The center shaft, or rotor, of a typical induction generator rotates at 1,500 to 2,000 rotations per minute (rpm).

sophisticated and more reliable transmissions (Figure D-5) can adequately maintain the rotational speed of the electric generator's central shaft at much lower rates of rotor rotation. This results in substantial additional benefits, including reductions in the bending moments on the blades and reductions in the forces on the turbine drivetrain, by minimizing the effective weight of the rotor.

Wind turbine designers concern themselves not with the blade's tip speed but rather with the tip speed ratio, which is defined as the ratio of the angular velocity of the blade tip to the mean velocity of the wind entering the rotor. For a given mean wind velocity and a rotor with a given number of blades, the design objective is to select a tip speed ratio that maximizes the opportunity for the incident wind to interact with the turbine blades and impart aerodynamic lift while simultaneously minimizing the disruptions of airflow ahead of the rotor blades. A rotor spinning too fast will present a greater obstruction to incident wind. Conversely, a rotor revolution that is too slow will allow large amounts of air to pass through the rotor's plane without ever interacting with a turbine blade and imparting aerodynamic lift. At a given mean wind speed, the power coefficient of a turbine initially increases with an increasing tip speed ratio until a maximum is reached; beyond this point, performance actually decreases with further increases in the tip speed ratio. A more detailed discussion of this relationship and the influence of the Betz limit on turbine performance is provided by Burton et al. (2001). The ideal tip speed ratio is empirically derived and is inversely related to the number of blades. Because the rotor's (and the turbine's) power coefficient is directly related to the tip speed, controlling that ratio is a desirable objective. For a specific rotor operating in a given wind regime, the tip speed ratio at which maximum performance is achieved becomes the controlling design basis value.

In addition to the basic performance relationship between the blade's tip speed and the turbine's power coefficient, two impacting factors are directly related to rotor rotation and tip speed: aerodynamic noise and shadow flicker. Both can influence turbine design decisions. The aerodynamic noise generated by a wind turbine is proportional to the fifth power of the tip speed.[9] Thus, small variations in tip speed can dramatically affect the noise profile of a wind turbine. Empirical data have led turbine designers to limit the tip speed to no more than 213 ft/s (65 m/s). Limiting the tip speed (which is proportional to the rotor's rate of rotation and based on the swept area of the rotor) and limiting the distance to the nearest habitation to at least 1,312 ft (400 m) are expected to result in a turbine noise level at or near ambient levels (Burton et al. 2001). However, other factors, such as the height of the rotor and the topography of the site, can significantly influence the propagation of sound energy.

In addition to the mathematical and geometric relationships between the rotor's rate of revolution and the tip speed and the relationships between the tip speed ratio and the power coefficients, rotor revolution can also cause a visual phenomenon unique to wind turbines known as shadow flicker. Shadow flicker refers to the shadows that a wind turbine casts over structures and observers at times of the day when the sun is directly behind the turbine rotor from an observer's position. Shadow flicker is most pronounced in northern latitudes during winter months because of the lower angle of the sun in the winter sky. However, it is possible to

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9 The angle at which the airfoil of a rotor blade faces the wind, sometimes known as the angle of attack, can also influence the production of aerodynamic noise.

encounter shadow flicker anywhere for brief periods after sunset and before sunrise. Empirical data suggest that shadow flicker can have a disorienting effect on a small segment of the general population. Empirical data also suggest that limiting the frequency of rotor rotation to below 2.5 Hz can mitigate the deleterious effects of shadow flicker.[10] Burton et al. (2001) indicates that limiting a (three-bladed) rotor revolution to 35 rpm will result in a blade passing frequency of 1.75 Hz (i.e., where the passing is between the sun and the observer). Increasing the spacing between a turbine rotor and the nearest observer to at least 10 rotor diameters also dramatically mitigates shadow flicker effects.

Finally, another closely related phenomenon is "blade glint," which is the reflection of sunlight off the surfaces of rotating blades. Such glint can also have a disruptive effect on some observers. However, as discussed elsewhere, the trend in the industry is toward longer blades. To control the resulting weight (and provide better aerodynamic properties), modern blades are now constructed almost exclusively of carbon composites or plastics, the natural surfaces of which are quite dull, especially relative to the steel and aluminum blades of the past. In the majority of cases, this technological development has made blade glint a relatively moot point with regard to modern turbines.

D.5.5 Blade Length and Tower Height

Because the speed of the incoming wind cannot be controlled, attaining and maintaining the ideal tip speed ratio involves controlling the tip speed. There are two paths to this objective: changing the rate of rotor rotation or increasing the blade length. Increasing the blade length is often the preferred option for a number of engineering reasons. However, the law of diminishing returns is also at play here. Larger rotor diameters result in additional bending moments on the blades that must be accounted for. Longer blades mean additional rotor weight and increased strain on the mechanical drivetrain components. Research on alternative materials and fabrication procedures is being conducted by turbine manufacturers and under government sponsorship. (See Section D.7 for more details on blade research.) Preliminary DOE-sponsored research on the technological impediments to scaling up current blade designs has identified the need to modify construction materials and processes (Griffin 2002) and the need to take a fundamentally different approach to airfoil design for extremely long blades (TPI Composites, Inc. 2002).

To accommodate longer blade lengths, the turbine support towers have to be taller and more substantial. Irrespective of blade length, taller towers allow the rotor to operate in geostrophic wind regimes above the interferences introduced by surface topography. Principal performance factors affecting tower height selection include the wind profiles of the candidate site and the blade length of the turbine model selected. Costs of fabrication and erection are balanced against the performance advantages. Other factors related to site conditions can also influence tower height selection. These include access to the site by the larger equipment needed to transport towers (or tower segments), longer blades, and lifting/erection equipment; temporary

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[10] One hertz, or one cycle per second, is equal to 1/60th rpm.

amendment of site surface conditions to accommodate erection activities; and subsurface conditions that could affect the difficulty and the cost of constructing sufficient foundations for larger towers.[11] Installation costs, site access, and transportation logistics are important limiting factors with regard to tower height, and all factors must be considered in calculating improved performance with height. Developers are not likely to erect towers any taller than necessary to achieve economic power production (Steinhower 2004).

The principal impacting factors that directly relate to a rotor's geometry and the elevation at which it operates are listed below:

- Larger rotors require higher, more formidable towers that are more expensive to fabricate and erect.
- Higher towers, in turn, are visible from greater distances, increasing the size of the impacted viewshed.
- Larger rotors allow for the economical capture of wind energy at slower rotor revolutions, which could lessen or completely eliminate the adverse viewshed impacts and bird-strike hazards.
- Larger rotors can rotate at frequencies less than the frequencies that induce shadow flicker.
- Larger rotors operating at fewer rotations per minute produce less aerodynamic noise than their smaller counterparts, which must rotate faster to capture the same amount of wind energy.

D.5.6 Grid Interconnection Issues

The distance to an existing transmission line of suitable voltage and with reserve power-carrying capacity is a critical factor to consider with regard to future wind energy development projects, because the wind farm developer is expected to absorb the cost of establishing the physical link from the wind farm to the nearest existing transmission grid.[12] However, connecting to the grid is not necessarily a straightforward process. In reality, many factors related to grid interconnectivity can influence site development costs, design selection, initial installation and subsequent operating costs, and ROI schedules.

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[11] However, innovative tower designs can dramatically influence erection costs and simplify transportation logistics. See Section D.7.1 for additional discussion.

[12] Detailed discussions on the development of interconnecting links to existing transmission lines are provided in the cumulative impacts portion of this PEIS. Nevertheless, the development of power links between any wind farm and existing power transmission lines will receive separate National Environmental Policy Act (NEPA) evaluations, which are outside the scope of this PEIS.

To prevent disrupting the grid, the electric power generated at the wind farm must first be conditioned. This requires installing various power management and conditioning devices. Other devices are required to automatically isolate a wind farm from the grid during certain disruptive events. Sophisticated supervisory control and data acquisition (SCADA) systems are also required to ensure that the operating conditions of both the individual turbines and the overall wind farm and any rapid changes to grid interconnections are adequately controlled, in order to prevent the effects of potentially damaging disruptive events at the wind farm from cascading onto the grid.

Although power management and control devices and SCADA systems certainly affect site development costs and the ability of the wind farm to interconnect to the grid, they represent only an incremental change to the footprint of the wind farm, and most have little or no direct or cumulative environmental impacts.[13] There are two notable exceptions, however: "voltage flicker" and lightning protection.

If not adequately conditioned and controlled, wind farm power introduced onto the grid can result in voltage flicker. Voltage flicker occurs when changes to the network voltage occur faster than steady-state voltage changes that exist within the transmission system. Voltage flicker can cause perceptible changes to the brightness of incandescent lights that draw power from the grid. Such changes, in turn, can have a disorienting effect on certain individuals. Transmission grid operators can be expected to require wind farm operators to establish power management systems capable of eliminating conditions leading to voltage flicker.

Lightning protection is also required for wind farm components to prevent catastrophic impacts to the grid. Each individual turbine tower on the wind farm, as well as the electrical substation, must be protected, and control systems must be capable of isolating the wind farm from the grid during upset conditions caused by lightning. Although lightning protection technologies are available, their application in some wind farm settings may appreciably increase site development costs. Conventional lightning control involves providing a low-impedance path for the lightning's electrical energy to pass to the ground.[14] To establish adequate lightning protection for wind farms developed on rocky ground where there is no soil mantle, it may be necessary to drill one or more wells into which a current-conducting metal rod is inserted to extend the grounding path to the nearest aquifer. Moreover, the aquifer must be continuous over a large area rather than perched to provide reliable protection. In some western states within the study area, the nearest appropriate aquifer may be thousands of feet below a candidate wind site. Installation of such grounding wells will increase costs — not only costs directly related to well

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13 Although many issues associated with power management and control and interconnection to the grid are outside the scope of this PEIS, they are, nevertheless, expected to be stipulations to any agreement between a power transmission company and a wind farm operator regulating grid interconnection.

14 Where the soil mantle provides adequate grounding capacity, lightning protection systems routinely involve one or more grounding rods. For electrical substations, this grounding path is often enhanced by the installation of a grounding grid of wire located below the entire footprint of the substation and at some depth below the ground surface.

installation, but also costs to support the hydrogeologic studies that may be required to identify appropriate aquifers.[15]

D.5.7 Variable versus Fixed Rotor Rotation

Wind turbines can be designed to operate at both fixed and variable rotor rotation speeds. Of the two systems, variable-speed systems are preferred for a number of reasons related to overall wind turbine performance. However, while variable-speed machines can take fuller advantage of variations in the incident wind speed, the alternating current (ac) electricity they produce has a variable frequency that cannot be safely delivered to existing power transmission grids without conditioning. Variable-speed wind turbines are routinely connected "indirectly" to the grid to allow this power conditioning to occur at the wind farm. The majority of modern turbines include transmissions, clutches, and rotor shaft braking systems or aerodynamic stall features that act on the rotor blades to maintain the variations in a rotor shaft's rotation within prescribed design limits. Such turbines are also equipped with SCADA systems that can adjust operating conditions (e.g., aerodynamic stall and blade pitch) to changing wind conditions. Variable-speed capability allows the turbine to operate at ideal tip speed ratios over a larger range of wind speeds. The most dramatic increase in performance is realized at lower wind speeds.

Wind turbines with either a fixed or variable rotor rotation speed can be outfitted with either synchronous or asynchronous electric power generators.[16] In general, initial installation costs for asynchronous generators are lower, and the generators are generally very reliable. More important, asynchronous generators have mechanical properties that make them very suitable for wind turbine applications, including good overload capabilities and a relatively small generator slip.[17] Asynchronous generators can easily accommodate changes in the torque applied by the wind turbine's rotor shaft (through the transmission), thus reducing overall mechanical wear and tear over the generator's operating life. Because of the relatively constant operating conditions of asynchronous generators, turbines equipped with such generators are normally directly connected to the grid with little additional conditioning.

The use of synchronous electric generators rather than induction generators improves the wind turbine's overall power-generating performance and reduces the likelihood that the turbine will be a source of harmonic electric currents that can be disruptive to the power grid. However,

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[15] Properly designed and installed "grounding wells" have no potential to adversely impact groundwater quality.

[16] Asynchronous generators are also commonly called induction generators. Expanded discussions on electric generators are available in appropriate engineering textbooks. A simplified discussion regarding generators used in wind turbines can be found in DWIA (2004).

[17] The difference in rotational speeds of the generator at idle and at peak load is called the generator slip, expressed as a percentage of the synchronous speed. Thus, the rotational speed of the generator's center shaft (called the stator), which is turned by the action of the turbine rotor, varies little over the entire operating range of the generator.

initial installation costs are higher, and the power produced by synchronous generators must first be conditioned before delivery to the grid, further increasing installation and operational costs.

As rotor diameters increase, the turbine's rated power increases proportionally to the square of the rotor diameter. The amount of torque produced by the rotor shaft also increases markedly, placing significant operating demands on transmissions and generators. Industry and government researchers are now exploring the use of multiple generators or the use of multipole generators as a way of distributing torque and reducing its damaging effects on mechanical systems (Cotrell 2002). The use of multiple generators operating at different shaft speeds is also being investigated as a means of producing optimal levels of power at more widely varying rotor rotational speeds. Regardless of turbine and generator design choices, the attendant power-conditioning prerequisites do not themselves have additional environmental impacts of any significance.

Operation at variable rotor speeds increases the complexity of the initial turbine design as well as the SCADA system required. However, it also promises to increase the overall longevity of major system components and to reduce O&M costs. Thus, turbines with variable-speed rotors can be expected to have less of an environmental impact over their operating lives than would their fixed-speed counterparts.

Wind farms could consist of a mixture of fixed-speed and variable-speed turbines. Although the development costs of such a wind farm would be incremental, the increased sophistication of power management systems and SCADA systems and the expected greater O&M costs of such a configuration make such a wind farm unlikely. Wind farms consisting of identical turbines operating at different rotor elevations in order to take the fullest advantage of existing wind profiles are still a conceivable option, however.

The following impacting factors relate to rotor operation at a variable rotation speed:

- Reducing the dynamic forces on the turbine drivetrain, extending the operating lives of major components, extending the maintenance intervals, and reducing the incidence of breakdowns, all of which would result in a smaller environmental impact over the life of the wind farm;

- Allowing the turbine to be "elastic" with respect to its interaction with the grid, thereby reducing the generation of power harmonics that can be disruptive to the grid; and

- Allowing the turbine to efficiently generate power at lower wind speeds, thus reducing the aerodynamic noise signal of the blades.

D.5.8 Micrositing and Site Development

Once a candidate site has been selected and more detailed meteorological data have been gathered for a minimum of 1 year, site developers have the data necessary to make micrositing

decisions (i.e., determine the precise location on the site at which the wind turbines will be located). The natural turbulence at the site due to the surface topography and obstructions and the induced turbulence of each wind turbine tower are the primary factors that govern turbine micrositing. Empirically derived nomographs[18] exist that indicate the necessary minimum distances for turbine placement from natural obstructions; however, they are often imprecise. Improving the methods for characterizing site-specific turbulence and understanding the influence of turbulence on site development make up a major ongoing R&D initiative (Section D.7). It is possible that site developers may find it appropriate to remove some natural obstructions (e.g., trees) to mitigate turbulence caused by natural obstructions.[19] It is also reasonable to conclude, however, that the extent to which natural features of the site will be altered to improve the wind regime will be limited by site development costs. Thus, while tree removal is a feasible step associated with site development, major alterations of the existing grade over a large scale are not.

It is also reasonable to expect that a site developer will seek to take advantage of economies of scale and develop a candidate site to its fullest potential. Thus, multiple turbines will likely be erected, and turbulence considerations will again be the primary factor governing their number and interspatial relationships.[20] Empirical nomographs that describe the induced turbulence of a wind turbine and its tower and that indicate the minimum distance of separation needed to avoid such interferences will likely be used to support micrositing decisions. (Research is ongoing to develop more precise modeling tools for characterizing the wind regimes on a site; see Section D.7.) Avoiding the wind shadow of turbines will probably be a first priority in siting multiple turbines, and access to the indicated micrositing location will be of secondary importance. Pursuing economies of scale in site development will amortize site characterization and site development costs. However, the extent to which a site will be developed can have additive effects on many of its impacting factors.

Primary impacting factors related to site development and micrositing include the following:

- Potential for ancillary activities, such as tree and vegetation removal, that will result in surface scarring and additional impacts to the viewshed beyond the impact of turbine visibility itself;

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18 A nomograph is any chart representing numerical relationships. In this case, the relationship is between the degree of turbulence and the distance from a wind turbine to any natural or human-made wind obstruction, including other turbines.

19 However, for wind turbines operating on very tall towers with their rotors largely within the geostropic wind regime, even mature trees represent relatively inconsequential ground-level obstructions to winds at the turbine hub's elevation.

20 The rotation of both a turbine rotor and the support tower induce turbulence in the downwind direction. Spacing of wind turbines to avoid turbulence effects is usually represented by rotor diameters. Normally, a distance of 10 rotor diameters is considered to be the minimum downwind distance for spacing turbines in the downwind direction.

- Increased potential for fugitive dust, proportional to the area of disturbed ground surface;

- Potential for invasive species being established in disturbed areas before indigenous vegetation can be reestablished;

- Potential for bird strikes, generally proportional to the number of turbines installed;

- Increased time required for construction, with proportional increases in both the magnitude and duration of impacts related to construction;

- Potentially additive impacts from individual turbines, including noise and viewshed impacts; and

- Proportional increases in O&M costs, including costs to deal with wastes associated with system maintenance and repair.

D.6 COMMERCIAL WIND ENERGY INDUSTRY PROFILES

This section provides an overview of the existing commercial wind energy industry within the study area. The AWEA compiles and maintains data on commercial wind farms.[21] The review and analysis of these data provide a reasonable basis from which to anticipate the characteristics of future wind farms.

Industrywide reviews of the commercial utility-scale wind energy industry have identified the following important trends, each of which will greatly influence future wind farms.

- In general, average individual wind turbine power-generating capacities have steadily increased in North America, from 500–750 kW in the late 1990s to megawatt-capacity turbine installations beginning in 1999, resulting in typical wind farm generating capacities of 50 MW or larger (Kaygusuz 2004).

- The (worldwide) average growth rate of the cumulative installed wind energy power-generating capacity over the period 1998 to 2004 has been about 30% per year (Kaygusuz 2004).

- As the understanding of aerodynamics has been increasing and as designs have been defined, wind turbine efficiencies have been increasing, especially for turbines with larger rotor-swept areas. Average annual yields per unit of rotor-swept area (RSA) have increased by more than 50% as rotor diameters have increased from 66 to 262 ft (20 to 80 m) (Milborrow 2002).

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21 The text box on the next page describes the AWEA and information compiled by the AWEA regarding the wind energy industry.

- Wind turbines now have power-generating capacities of as much as 600 W/m^2 of RSA.

- Three-bladed, upwind turbines dominate the commercial utility-scale market (Milborrow 2002).

- The majority of wind turbines run at fixed rotor speeds and utilize induction generators. However, newer models equipped with sophisticated electric power conditioning controls have rotors that run at a variable rotational speed (Milborrow 2002).

- Newer-model turbines tend to run at slower rotor rotational speeds but have relatively high energy capture/conversion efficiencies (Milborrow 2002).

About the AWEA

The American Wind Energy Association (AWEA) is a national trade association that represents wind power plant developers, wind turbine manufacturers, utilities, consultants, insurers, financiers, researchers, and others involved or interested in the wind energy industry. The AWEA provides up-to-date information on wind energy projects operating worldwide and projects under development, and it conducts technology and policy development activities related to wind energy.

The AWEA compiles and regularly updates relevant domestic and worldwide statistics on the wind energy industry and makes them available to industry participants, the interested general public, and the news media. These data are available at the association's Web site at http://www.awea.org. Also available on the AWEA Web site is access to various wind-energy-related information resources, including wind energy fact sheets and a catalogue of related publications. The AWEA also publishes a weekly newsletter devoted to wind energy news and hosts an annual national conference, WINDPOWER. Detailed information on AWEA activities and services can be obtained by visiting the Web site.

Information developed by the AWEA has been incorporated into this PEIS without independent verification. The BLM does not endorse the AWEA and does not make any warranty regarding the accuracy or completeness of the data it provides.

Although the commercial wind energy market in the United States has existed for some time, it has only recently (since 1999) begun to experience substantial growth, with calendar years 2001 and 2003 witnessing the two largest single-year's growth. Figure D-6 graphically depicts the rise in wind energy capacity (nameplate ratings in megawatts of electricity; the bars in the foreground represent capacities added annually; the bars in the background represent cumulative power capacity) over the period from 1981 through 2003. Data published by the AWEA indicate that the total installed capacity for all domestic commercial wind energy as of December 2003 was 6,374 MW, with 1,687 MW coming on line in 2003, which was a 36% increase from the capacity at the previous year's end (AWEA 2004d). Calendar year 2003 compared favorably with the previous year, showing a worldwide increase in capacity of 6,868 MW to reach a total of 31,128 MW and a U.S. increase of 410 MW to reach a year-end total of 4,685 MW, which represents 15% of the world's market (AWEA 2003a). Of the current total domestic capacity of 6,374 MW, 2,999.7 MW (or 47%) is being produced in the 11-state study area of this PEIS. The increase in overall generating capacity has been accompanied by a steady increase in individual turbine proportions and capacities. In the late 1980s, average turbine power outputs averaged 450 kW. Outputs increased to an average of 600 to 750 kW by the late 1990s. Now, individual turbines with ratings greater than 2 MW (2,000 kW) are commonplace (McGowan and Connors 2000).

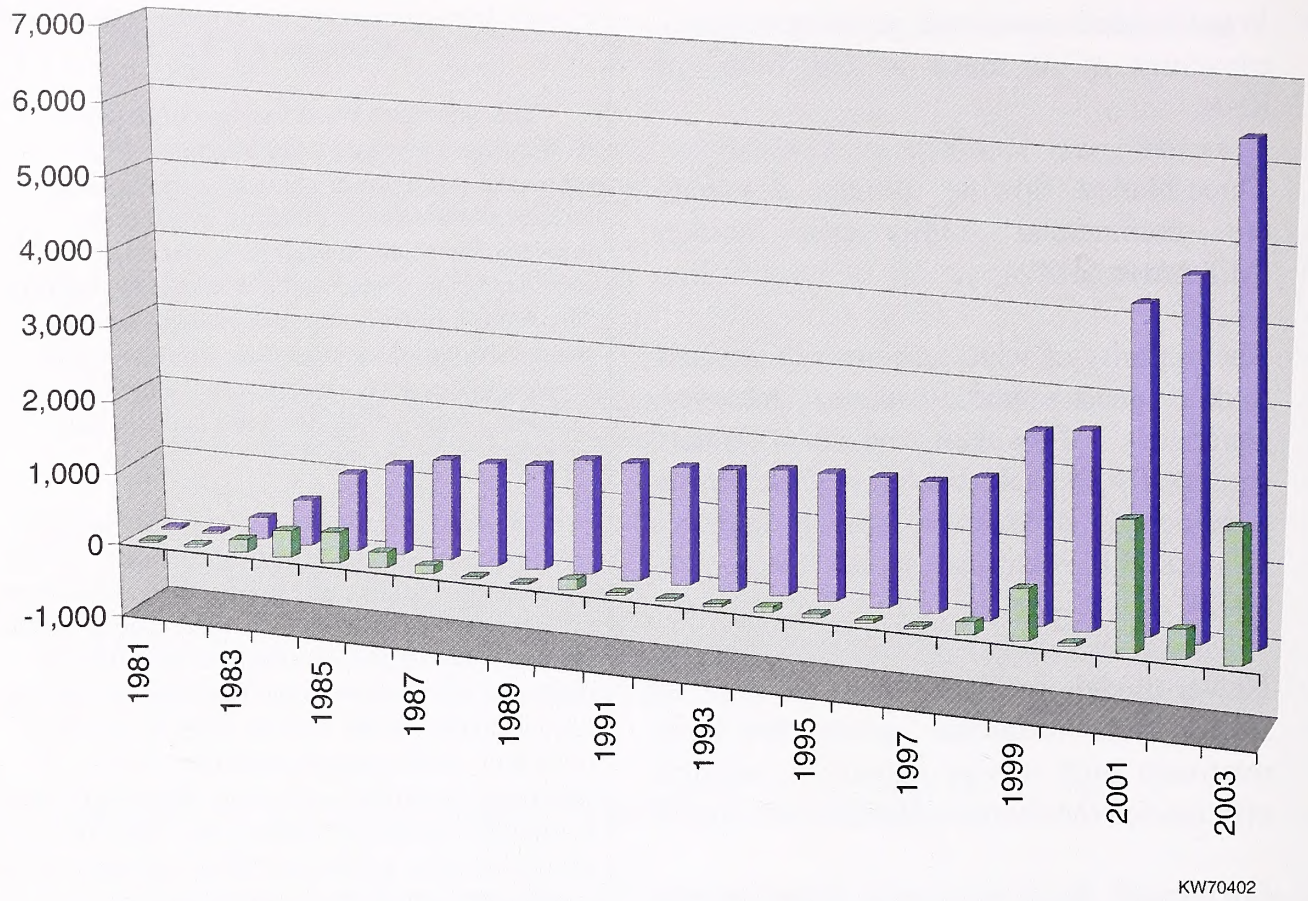


FIGURE D-6 U.S. Installed Capacity (MW) for 1981 through 2003 (Source: AWEA 2004d. Reprinted with permission. Courtesy of the AWEA.)

Figure D-7 shows the distribution of wind energy power-generating capacity across the United States. The numbers represent power capacities of utility-scale wind farms only, all of which deliver power directly to the electric power transmission grid. Additional power capacities from distributed energy systems are not included. The power capacities represent nameplate ratings and are rarely realized in practice. (See the discussion on typical capacity factors in Section D.5.2.) Within the 11-state study area for the PEIS, the total installed wind energy capacity is 2,999.7 MW.

Table D-1 lists the commercial wind energy projects completed in 2003. Projects completed within the 11-state study area are in bold type. The projects listed in the table represent new wind farms and phased expansions, or "repowering" of existing wind farms (i.e., replacing existing turbines with ones of newer design). Facility expansions and repowering activities are not expected to have the same array and magnitude of impacting factors as would a completely new facility. By definition, such site modifications are outside the scope of this PEIS.

In general, the number of manufacturers of wind turbines has greatly decreased from earlier years. In fact, a number of manufacturers have gone out of business. However, also represented in this decline are a number of mergers among manufacturers.

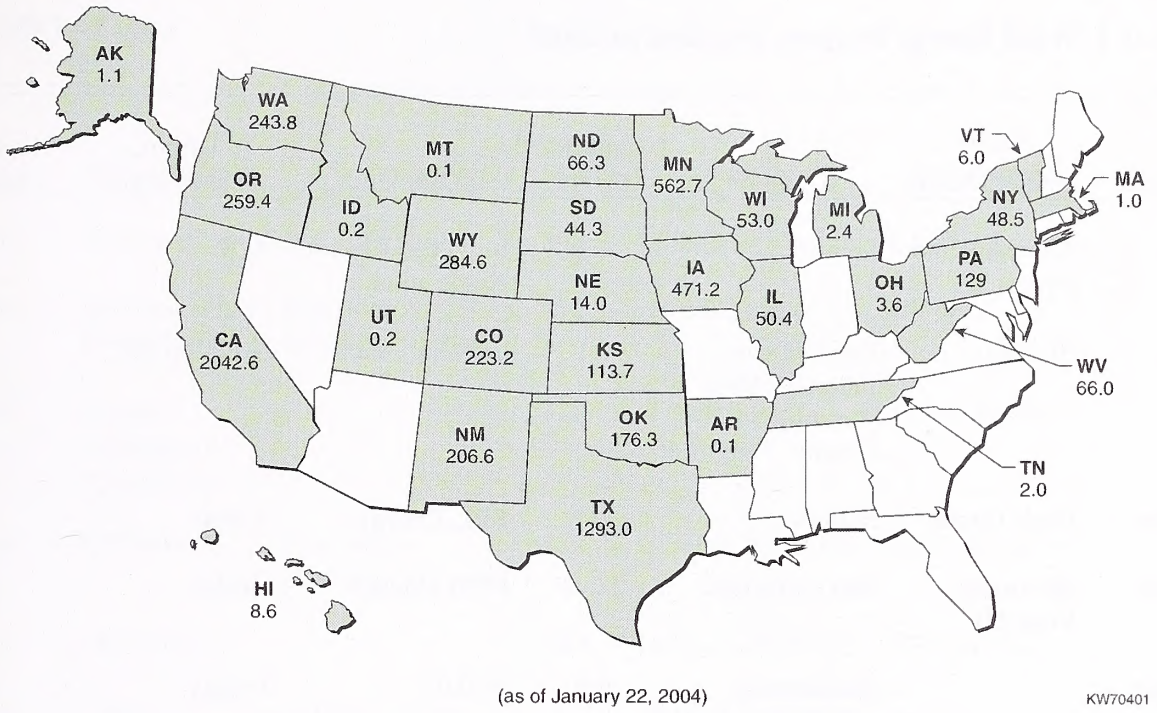


FIGURE D-7 Wind Energy Projects in the United States (Source: Adapted from AWEA 2004a. Reproduced with permission. Courtesy of the AWEA.)

Table D-1 lists the manufacturers of commercial wind turbines whose products were installed in U.S. wind farm projects in 2003. Although there are many other manufacturers, those listed in Table D-1 nevertheless represent a cross section of vendors. One should therefore take a more careful look at the turbine models offered by these vendors. Table D-2 lists the ranges of values for critical parameters of wind turbines installed in 2003. Although it is assumed that installations in 2003 constitute a reasonable representation of the most current facility installations and expansions, there is still a possibility that future wind farms will utilize turbines from other manufacturers. Nevertheless, it is reasonable to assume that the turbines installed in 2003 met the technical requirements of the sites at which they were installed. It is therefore also reasonable to assume that future developments at sites with similar wind regimes may also utilize turbines with these approximate specifications.

It is not the BLM's intention to endorse any specific equipment manufacturer.[22] Consequently, rather than present the specifications of individual turbines, the table displays a range of values for each parameter that is addressed. Only design specifications that were readily available from manufacturers' Web sites are included in the range calculations. Not always accurately reflected in the range value displayed, but nevertheless important for anticipating future wind farm characteristics, is the fact that many manufacturers offer modules rather than complete turbines, providing a number of options for each major component. Thus, the developer can custom build a turbine that is precisely suited to a particular site's wind conditions and to the

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[22] For a comprehensive list of turbine manufacturers, consult AWEA (2004b) or commercial business source guides such as Momentum Technologies, LLC (2004).

TABLE D-1 Wind Energy Projects Installed in 2003[a]

State	Project Name	Location	Capacity (MW)	Developer	Turbine Manufacturer	No. of Wind Turbines
Alaska	Selawik Wind Project	Selawik	0.2	Kotzebue Electric Association	AOC	4
Arkansas	Bitworks	Prairie Grove Industrial Park, Washington County	0.1	Bitworks, Inc	NEG Micon	1
California	**High Winds**	**Solano**	**162**	**FPL Energy**	**Vestas**	**90**
California	**Mountain View III**	**San Gorgonio**	**22.44**	**PPM Energy**	**Vestas**	**34**
California		**Sacramento**	**9.9**	**SMUD**	**Vestas**	**15**
California	**CalWind II CEC-repower**	**Tehachapi**	**8.58**	**CalWind Resources, Inc.**	**Vestas**	**13**
California	**Whitewater expansion**		**4.5**	**Cannon Power Corp.**	**GE Wind**	**3**
California	**Karen Avenue II**	**San Gorgonio**	**4.5**	**San Gorgonio Farms**	**GE Wind**	**3**
Colorado	**Colorado Green**	**Near Lamar**	**162**	**GE Wind**	**GE Wind**	**108**
Idaho	**Lewandoski wind farm**		**0.216**	**Bob Lewandoski**		**2**
Illinois	Mendota Hills	Lee County, near Mendota	50.4	Navitas Energy	Gamesa Eolica	63
Iowa	Flying Cloud	Near Spirit Lake	43.5	PPM Energy	GE Wind	29
Iowa	Henry Hills	Osceola County, near Sibley	3.6	Northern Alternative Energy	Gamesa Eolica	2
Iowa	Lenox	Lenox	0.75	Lenox Municipal	NEG Micon	1
Iowa	Wall Lake	Wall Lake	0.66	Wall Lake Municipal	Vestas	1
Iowa	Sibley Hills	Near Sibley	0.66	Northern Alternative Energy	Vestas	1

TABLE D-1 (Cont.)

State	Project Name	Location	Capacity (MW)	Developer	Turbine Manufacturer	No. of Wind Turbines
Minnesota	Chanarambie	Murray County	85.5	enXco	GE Wind	57
Minnesota	Moraine Wind Power Project	Pipestone & Murray Counties	51	PPM Energy	GE Wind	34
Minnesota	Farmers' cooperative corporations		22.8	DanMar & Associates	Suzlon Energy	24
Minnesota	McNeilus	Near Minn. Highway 56	22.8	Garwin McNeilus	NEG Micon	24
Minnesota	McNeilus		16.5	Garwin McNeilus	NEG Micon	11
Minnesota	Viking	Murray County	12	Project Resources		8
Minnesota	McNeilus		6	Garwin McNeilus	NEG Micon	4
Minnesota	Fairmont	Fairmont	1.9	SMMPA	NEG Micon	2
Minnesota	Missouri River Energy Systems	Worthington	1.9	Missouri River Energy Systems	NEG Micon	2
Minnesota	Shaokatan Power Partners	Lincoln County, near Hendricks	1.6	Northern Alternative Energy	Gamesa Eolica	2
Minnesota	McNeilus		1.65	Garwin McNeilus	NEG Micon	1
Minnesota	Don Sieve Wind Farm	Lincoln Co.	0.95	Diversified Energy Solutions	NEG Micon	1
Minnesota		Lincoln Co.	0.9	Diversified Energy Solutions	NEG Micon	1
Minnesota	Pipestone School District		0.75	Pipestone School District	NEG Micon	1
New Mexico	**New Mexico Wind Energy Center**	**Quay, DeBaca Counties**	**204**	**FPL Energy**	**GE Wind**	**136**
New Mexico	**Llano Estacado Wind Ranch at Texico**		**1.32**	**Cielo Wind Power**	**Vestas**	**2**

TABLE D-1 (Cont.)

State	Project Name	Location	Capacity (MW)	Developer	Turbine Manufacturer	No. of Wind Turbines
North Dakota		Near Edgeley	40.5	FPL Energy	GE Wind	27
North Dakota		Near Kulm	21	FPL Energy	GE Wind	14
Ohio		Bowling Green	3.6	Bowling Green Municipal	Vestas	2
Oklahoma	Blue Canyon Wind Power	North of Lawton	74.25	Zilkha Renewable Energy & Kirmart Corp.	NEG Micon	45
Oklahoma		Near Woodland	51	FPL Energy	GE Wind	34
Oklahoma		Near Woodland	51	FPL Energy	GE Wind	34
Oregon	**Combine Hills**		**41**	**Eurus**	**Mitsubishi**	**41**
Pennsylvania	Waymart	Clinton & Canaan Township	64.5	FPL Energy	GE Wind	43
Pennsylvania	Meyersdale	Somerset	30	FPL Energy	NEG Micon	20
South Dakota	Highmore	Near Highmore	40.5	FPL Energy	GE Wind	27
South Dakota	Rosebud Sioux		0.75	DisGen	NEG Micon	1
Texas	Brazos Wind Ranch	90 miles south of Lubbock	160	Cielo Wind Power/Orion Energy	Mitsubishi	160
Texas	Sweetwater	Sweetwater	37.5	DKR/Babcock-Brown	GE Wind	25
Texas	Hansford County, Texas		3	FPL Energy	Vestas	1
Texas	Indian Mesa		3		Vestas	1
Washington	**Nine Canyon, Phase II**	**Benton County**	**15.6**	**Energy Northwest**	**Bonus**	**12**
Wyoming	**Evanston**	**Evanston**	**144**	**FPL Energy**	**Vestas**	**80**

[a] Bold type indicates projects within the 11-state study area.

Source: Adapted from AWEA (2003b). Reprinted by permission. Courtesy of the AWEA.

TABLE D-2 Specifications for Wind Turbines Installed in 2003[a]

Parameter[b]	Ranges for Available Options[c]
Power (nameplate rating)[d]	200 kW–3.6 MW
Turbine type	Upwind HAWT
Cut-in speed (m/s)	2.5–4.0
Nominal wind speed (m/s)	11–16
Cut-out speed (m/s)	25
Rotor diameter (m)	30–104
Rotor-swept area (m^2)	706–8495
Rotor speed (rpm)	8–46
Rotor hub height (m)[e]	30–120
Tower construction material	Cylindrical or tubular steel, hot-dip galvanized lattice steel, combination concrete and tubular steel
Tower weight (kg)[f]	<30,500–216,780
Nacelle weight (excluding rotor) (kg)[e,f]	<19,954–55,329
Rotor weight (kg)[g]	<9,070–30,839
Total weight (kg)[h]	<37,188–158,300

[a] Data presented in this table represent the range of options offered by the manufacturers listed in Table D-1 for which data were readily available. No attempt was made to identify the specific turbine models used in the 2003 projects. Instead, all available models of the manufacturers listed were used to compute the ranges. Additional information on individual turbine models is available at that turbine manufacturer's Web site. Web sites are listed here as follows:

Atlantic Orient Corp.	http//www.aocwind.net/specs.htm
Bonus Energy Products	http//www.bonus.dk/uk/produkter/
Gamesa Eolica	http//www.gamesa.es/ingles/nucleos_negocio/gamesa_eolica/presentacion/presentacion.htm
GE Energy	http//www.gepower.com/businesses/ge_wind_energy/en/products.htm
Mitsubishi Electric	http//www.global.mitsubishielectric.com/bu/windpower/index2_b.html
NEG-Micon	http//www.neg-micon.com (Only limited data are available; data are not included in ranges presented in the table.)
Suzlon Energy	http//www.suzlon.com/technical_data
Vestas Wind Systems A/S	http//www/vestas.com/produkter/

[b] By industry convention, all specifications are presented in metric units.

[c] Range does not include data from AOC Model 15/50 turbine, the use of which has been confined to distributed energy systems in remote locations.

[d] Range represents individual turbine nameplate ratings. Additional specifications for power generation and management devices are available at the manufacturers' Web sites. However, since these devices have little or no influence on the environmental impacts of an operating wind turbine, they are not represented here.

[e] Rotor hub height is considered to be approximately equivalent to tower height, measured from ground elevation.

Footnotes continued on next page.

TABLE D-2 (Cont.)

[f] All weights are approximate; the weight range is based on models manufactured by Vestas Wind Systems A/S and Bonus Energy Products only. The weight of the smallest tower option was not available.

[g] Rotor weight includes active pitch control equipment, if present.

[h] Nacelle weights may differ as a result of drivetrain component selection.

Source: Derived from AWEA (2003b).

stipulations of a particular interconnection agreement with the transmission line operator. For the reader's convenience, the Web sites for the manufacturers whose turbines are represented in the range of values displayed are provided as footnotes to Table D-2.

The data displayed in Table D-1 appear to support the following conclusions about the characteristics of future wind farms. Notwithstanding the fact that calendar year 2003 was an exceptional year for industry growth, a reasonable assumption is that the projects that went on line in 2003 reflect the state of the technology with respect to commercially available wind turbines. Another reasonable assumption is that the wind turbine models installed in 2003 offered operating parameters that matched well with the specific conditions at the sites at which they were installed. A further assumption is that future sites with wind characteristics similar to those at sites developed in 2003 will utilize turbines with operating parameters similar to those displayed in Table D-2.

Following a strategy of extracting the maximum potential wind energy from a given site will minimize the overall environmental impacts. However, phased site development can cause changes to some impacting factors related to site development and operation. Some of the impacts in phased development will simply be additive over time. For example, the noise levels from individual turbines will be logarithmically additive for each turbine installed; however, because of the expected distances between turbines in a typical wind farm, the addition of each turbine will increase the area potentially impacted by noise, but it will not substantially increase the average or maximum noise levels throughout that area. Site topographic features can also greatly influence noise levels at a given distance from a noise source. See Section 4.5 of the PEIS for a detailed discussion on noise generation and propagation and Section 5.5 for a discussion on potential noise impacts from wind farms. Impacting factors associated with turbine foundations and erections will also be additive within a given phase of development and then reoccur during subsequent development phases, although not necessarily at the same magnitude or for the same duration. Other impacts related to initial site development may not reoccur at all during subsequent site expansions. For example, if it is assumed that the initial site development plan accounts for all future site expansions, a single main site access road can be selected and constructed as part of initial site development, and it can continue to serve as the site access road for subsequent phases of development. In such a scenario, only the expansions of on-site roads would be impacting factors in later development phases.

D.7 WIND ENERGY TECHNOLOGY RESEARCH AND DEVELOPMENT

A review of the current state of the commercial wind turbine market can provide a basis for predicting the types of turbines that are likely to be installed at future sites. However, it is also reasonable to predict that future site developers will avail themselves of technological advances and improved performance models. Therefore, a brief review of wind energy industry R&D activities is warranted. Although much of the R&D effort has been undertaken by the equipment manufacturers, the federal government also provides support. The discussions below are confined to R&D activities unique to the commercial wind energy industry. Note that R&D efforts to improve the design and performance of many of the major components of a wind turbine, such as transmissions and electrical generators, are also ongoing within the respective industry sectors. Likewise, R&D efforts in the general area of monitoring and control systems continue as well. Although these R&D efforts are not discussed here, it is assumed that wind farm developers and/or equipment manufacturers will incorporate technological advances from these other sectors into their wind farms and turbines at appropriate times.

D.7.1 Industry-Sponsored Research and Development

Leading equipment manufacturers are already engaged in R&D on many aspects of their products. Their primary objective is to maintain or improve their competitive positions in the markets in which they operate. R&D can also help them conform to quality standards (Section D.8).

Industry research focuses on improving the reliability of major components, improving overall efficiency, reducing manufacturing costs, and mitigating the adverse aspects of individual products. For example, manufacturers who hope to participate in the European wind energy market are exploring ways to mitigate the noise signals of their equipment. Because most wind farms in Europe are located close to inhabited areas, controlling noise is critical to maintaining market position. In its overview of worldwide wind energy industry trends, Shikha et al. (2003) found that continuous improvements were being made to applied technologies in the expanding wind energy industry. They found that energy output capacities of individual turbines increased 100-fold in the 15 years ending in 2003, while the overall weight of turbines was halved in the 5 years ending in 2003, and the noise emitted was halved over the 3-year period ending in 2003. Steady gains were attributed to a number of factors, including improved aerodynamics, improved structural dynamics, and improved micrometeorology, which resulted in precise turbine siting at the most ideal location. Additional improvements were attributed to the increase in rotor size and improved blade performance. Together with the benefits derived from reduced rotor weight, overall improvements in the drivetrain design and the reliability of individual components also resulted in a reduction in O&M costs. It is estimated that O&M costs constitute as much as 10 to 15% of the unit energy costs of a new wind farm; however, O&M costs increase to 20 to 30% near the end of the farm's design life (McGowan and Connors 2000). However, O&M costs are also expected to rise slightly over the design life of the turbine. Steady improvements in drivetrain design and efficiency are expected to reduce O&M costs from a U.S. average of $0.01/kWh in 1997 to $0.005/kWh by 2005 (McGowan and Connors 2000).

Manufacturers are also adopting modular design strategies that allow the replacement of individual turbine drivetrain components, thereby reducing downtime and costs. Often such strategies are further enhanced by equipping towers with internal lifting devices that allow the replacement of individual components without the necessity of bringing heavy-duty lifting devices to the site to remove the rotor assembly and/or the entire nacelle.

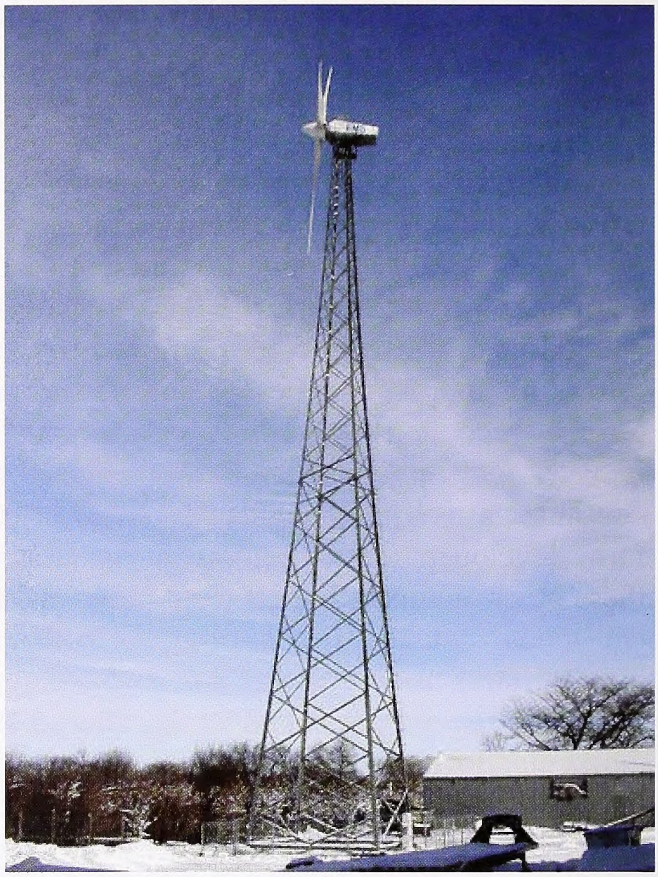


FIGURE D-8 Lattice-Type Wind Turbine Tower in South Dakota (A Vestas Model V17 wind turbine mounted on a lattice-type tower in Gary, South Dakota. Photo credit: Energy Maintenance Service, Inc., Sept. 1, 2002. Source: Photo # 12449, NREL 2004b.)

Although the majority of industry R&D initiatives focus on improving the design and efficiency of rotors and turbine drivetrain components, some innovative tower designs and materials can also affect future wind farms. Early wind farms utilized lattice-type towers (Figure D-8). However, smooth-skinned, tapered steel towers now dominate the commercial utility-scale market. The size and weight of the steel towers required for larger turbines increase installation costs and create significant problems related to the transportation of both the tower segments and the cranes required for their erection. A number of innovative tower designs and erection methodologies have been developed to overcome these impediments. Towers that can be erected by using mobile, temporary elevators have been developed, obviating the need for independent cranes and thus greatly simplifying erection costs and reducing transportation logistics (e.g., see Valmont 2004). A government-sponsored study completed in May 2001 identified a number of unique tower erection strategies and evaluated each against its impact on the overall cost of energy produced (Global Energy Concepts, LLC 2001). Two technologies were evaluated in depth and compared with conventional crane technologies. The study concluded that one of the two alternative erection methods compared favorably to conventional cranes for 1.5-MW and larger turbines, but it was more expensive than conventional cranes for smaller turbines. The study further postulated that alternative erection methodologies might be favored over conventional cranes for sites with complex terrain or difficult access, but they could be at a disadvantage at sites with significant wind shear. Other developments include constructing towers of tubular carbon composites in an integrated pyramidal shape, resulting in stronger and substantially lighter towers (e.g., IsoTruss Structures, Inc. 2004). Again, such lighter towers can substantially reduce transportation logistics and reduce site development costs.

D.7.2 Government-Sponsored Research and Development

Government-sponsored research and government-industry partnerships also account for a major portion of ongoing R&D efforts. DOE/EERE is the principal funding agency for government-sponsored research. Government participation also includes the personnel and facilities of NREL in Boulder, Colorado, and Sandia National Laboratories in Albuquerque, New Mexico. Government-industry partnerships proceed under the auspices of DOE's Cooperative Research and Development Agreement (CRADA) program. Under CRADA programs, government and industry collaborate to identify and better understand the fundamental science and engineering issues critical to technology advancement. Government personnel also conduct tests on prototypes and develop software that aids designers. Industries then have access to the published reports on CRADA research and use their contents to shape their own additional technology R&D. The government-industry partnership in DOE's Wind Energy Program is known as the Wind Partnerships for Advanced Component Technologies (WindPACT).[23]

DOE's R&D objectives and strategies are outlined in *Wind and Hydropower Technologies Program; Wind Energy Program Multi Year Technical Plan for 2004–2010* (EERE 2003). The overall strategic objective is to protect the nation's energy security by fostering the development of technologies that utilize a diverse supply of affordable and environmentally sound energy. Specific research objectives are defined in terms of reducing the ultimate costs of electricity generated by wind energy. Individual research initiatives, or technology improvement opportunities (TIOs), are distributed throughout all segments of the wind energy industry. The research initiatives of greatest importance to the utility-scale sector of the industry include improving the viability of low-wind-speed technology and facilitating the application of technologies and technological advances by engaging in fundamental research, developing quality standards and certification programs, conducting field verification tests, and analyzing and addressing technological and market impediments.

Researchers have identified a number of TIOs, including the following:

- Advanced drivetrain designs that use rare-earth permanent magnets for excitation, reduced gear box stages, and low- and medium-speed generators;
- Advanced power electronics that allow variable-speed operation while improving overall power capture/conversion efficiencies;
- Advanced rotors that use adaptive blades; and
- Advanced tower designs and materials that either reduce erection costs and simplify transportation logistics or are fabricated completely on site.

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[23] Many of the WindPACT technical reports may be accessed electronically at the NREL and Sandia Web sites; see NREL (2004a) and Sandia National Laboratories (2004d).

Research critical to the advancement of utility-scale turbines, especially in lower wind power classes,[24] includes the development of (1) advanced rotors; (2) a more complete understanding of a site's atmospheric dynamics; (3) improved generator, drivetrain, and power management subsystems; and (4) better integrated operational controls.

Turbines harvesting wind at lower wind classes are expected to need larger RSAs and operate at higher hub elevations. Rotor development focuses on the development of blades that are stiffer and stronger but also more slender, lighter, and more flexible (i.e., more adaptive to the dynamic forces they will encounter during operation). These apparently mutually exclusive characteristics hold the key to the successful advancement of large turbines. Although blade technology has already advanced significantly, it is thought that new materials and fabrication methods, as well as new design philosophies and criteria, will be necessary to support further substantial technological advances. Prototype blades made of long-fiber carbon composites are being tested for durability, and manufacturing processes are being refined.[25] If successful, this research will lead to turbines with greater RSAs and power-capturing efficiencies. There are, nevertheless, technical and economic limits to blade length. Rotor weight increases by the cube of its swept area, while the rated power efficiency increases by the square of the swept area. Consequently, there are some diminishing ROIs in the development of extremely long blades. Furthermore, with regard to extremely long blades, gravitational forces and torsional forces on the hub and the rotor shaft will become controlling forces in turbine design. Finally, as noted earlier, the torque produced by the rotor shaft increases with the square of the rotor diameter, thus significantly increasing the demand on transmissions and generators to withstand such increased torque moments. Some anticipate that the point at which these adverse forces will preempt rotor size expansions will be reached at rotor diameters of 256 ft (200 m), although the introduction of lightweight composites, such as fiber-reinforced plastics, may extend the practical rotor diameter to even greater values (Milborrow 2002).

Other possible dividends from increased blade length include lower operating costs and less aerodynamic noise. However, another real-world consequence of the use of very long blades is significant transportation logistics. Research conducted by Sandia and its contractor has explored the possibility of manufacturing turbine blades at the wind farm location (TPI Composites, Inc. 2003). The research concluded that on-site manufacturing was fraught with significant quality control issues and not feasible at this time. However, fabrication of the blades at nearby manufacturing sites (i.e., sites specifically constructed to support blade fabrication for use at a particular wind farm) was still considered feasible, since such a strategy would significantly reduce transportation distances and, if located judiciously, would significantly simplify transportation logistics. Other scaling and related logistics issues associated with transportation and erection also accompany any consideration for significantly enlarging wind turbines. WindPACT research initiatives will identify these obstacles and evaluate ways to overcome them.

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[24] Within the context of the WindPACT program, DOE defines lower wind classes as Class 4 and below (≤ 5.8 m/s [13 mpg] at a height of 10 m [33 ft]).

[25] See Sandia National Laboratories (2004c) for access to published reports of blade research being conducted by Sandia.

Up to this point of development, rotor aerodynamic design criteria have borrowed heavily from aerodynamic codes[26] developed in the aircraft industry. However, these codes do not reflect the aerodynamic conditions in which a wind turbine operates to a sufficiently high level of precision. New code development efforts are necessary to better understand the aerodynamic forces affecting both the performance and reliability of turbine rotor blades. Newly developed and validated codes will expedite the development of design criteria for longer, lighter, and more slender adaptive blades that can withstand dynamic forces and also impart minimum loads on the turbine drivetrain.

A more complete understanding of aerodynamic forces impinging on turbine blades will also allow designers to mitigate aerodynamic noise impacts. Another facet of research is the development of a semiempirical noise prediction code to be used by rotor and blade designers to ensure that new rotor systems have acceptable noise signatures.

As turbines become larger and operate at higher rotor hub heights, additional information about the atmospheric dynamics at these higher altitudes will be necessary to support design and micrositing decisions. It has already been established that the tallest turbines may be influenced by jet stream turbulence, especially by what are known as nocturnal jets (DOE 2002). Such turbulence is routinely present in low wind power classes, especially in the Great Plains regions. Successful advancement of wind turbines in such areas, especially in lower wind power classes, requires a much more complete understanding of jet stream turbulence and candidate site aerodynamics.

Other research initiatives on improving the power generation and management performance of the electric generator will have a direct impact on the interconnectivity of turbine power into the electrical grid but are expected to have little impact on environmental factors. Nevertheless, such improvements in overall turbine performance efficiency can be expected to reduce the mechanical noise emanating from the turbine blades and drivetrain components, as well as to reduce the number of breakdowns and maintenance shutdowns.

Finally, research on the advancement of integrated systems and controls attempts to enhance the precision with which turbines are monitored and controlled, promising better control of yaw and blade pitch to maximize performance. Such research pays its greatest dividends by improving the interconnection opportunities for wind farms. However, maintaining the turbine's operation at the highest performance level is also expected to improve overall reliability and reduce unwanted impacts that are manifestations of inefficiency (such as aerodynamic noise).

D.8 TESTING AND VERIFICATION PROGRAMS

DOE sponsorship of wind energy R&D also extends to field testing and verification programs. NREL and Sandia personnel, in collaboration with representatives of the Electric Power Research Institute (EPRI), other wind energy industry participants, and individual wind

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[26] Aerodynamic codes are an industry convention that describe the geometries of differently shaped airfoils.

farm operators, conduct evaluations of wind project development experiences and conduct field verifications of critical aspects of operational wind farms. The verification efforts help to identify issues related to site development, as well as design and operation, and provide the empirical basis for additional research on how to address or eliminate those issues. Published reports provide the opportunity for transferring lessons learned to other interested parties. Additional details about these verification programs and the published reports are available on the NREL and Sandia Web sites (NREL 2004c; Sandia National Laboratories 2004d).

D.9 STANDARDS AND CERTIFICATIONS

One clear indication of the maturation of the wind energy industry is the development and application of quality standards. International standards are already largely in place. Analogous U.S. standards are under development. Standards related to wind energy turbines promulgated by the International Electrotechnical Commission (IEC) are listed in Table D-3. The AWEA is the U.S. industry representative to this international standard-setting body. Many turbine manufacturers voluntarily conform to these standards to maintain their competitive position in the marketplace and to better guarantee the connectivity of wind-generated electric power to transmission grids. Conformance with international standards is a requirement for some wind farms in Europe.

U.S. wind energy industry consensus standards have been under development since 1974. The AWEA is the lead organization in domestic standard development. The development process involves the participation of various industry organizations, including the American Society of Mechanical Engineers (ASME), American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI), National Fire Protection Association (NFPA), American Gear Manufacturers Association (AGMA), and Institute of Electrical and Electronics Engineers (IEEE). Personnel from NREL and Sandia also participate in standards development. Domestic standards are expected to parallel and be compatible with IEC standards in order to ensure that American manufacturers maintain their access to European markets.

TABLE D-3 International Wind Turbine Standards

Standard No.	Title
IEC 61400-1	Wind Turbine Safety and Design
IEC 61400-1 Ed 2	Wind Turbine Safety and Design Revision
IEC 61400-2	Small Wind Turbine Safety
IEC 61400-12	Power Performance
IEC 61400-11	Noise Measurement
IEC 61400-13	Mechanical Load Measurements
IEC 61400-22	Wind Turbine Certification
IEC 61400-23	Blade Structural Testing
IEC 61400-21	Power Quality

In addition to quality standards for the design and construction of major turbine components, international standards are in place for the certification of turbines and ancillary systems by independent third-party auditors. Leading equipment manufacturers routinely submit their products and systems to such certifications so that they have evidence that their quality and performance goals have been met. Personnel from NREL are working in collaboration with Underwriters Laboratories, Inc. (UL) to develop analogous domestic certification standards and processes. Until those are in place, U.S. manufacturers are submitting their products and systems to certification against the international standards.

As the wind energy industry continues to mature, it is reasonable to expect that future wind farm developers and their equipment vendors will conform to applicable quality standards and submit their products and systems to third-party certifications. Conformance to quality standards and certifications provides a better guarantee of safe design and construction and generally increases both the reliability and performance of major wind turbine components. Given the levels of participation that already exist, it is reasonable to conclude that proposals for future wind farms and the equipment represented in those proposals will involve a commitment to conform to all applicable quality standards and to submit to all relevant third-party certifications.

D.10 IMPACTING FACTORS RELATED TO REASONABLY FORESEEABLE SITE DEVELOPMENT ACTIVITIES

The data in Tables D-1 and D-2 provide a reasonable representation of commercially available turbines and allow a reasonable prediction of the types of turbines that will be used in future sites. They are less adequate, however, in supporting further conclusions regarding site development. Nevertheless, past project experiences, together with the current state of wind energy technology and the advances expected from ongoing R&D activities, lend support to the following likely future site development scenarios.

- Business plans for future sites will involve developing candidate sites to their fullest wind energy potential as a means of quickly amortizing initial site development costs.

- The majority of large or extensive wind farms will probably be developed in phases, with the schedule of development being based largely on available development capital, as well as on myriad electric power market conditions. It is less likely that development will be speculative (i.e., built in advance of electric power sale agreements with transmission line operators) (Osborne 2004).[27]

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27 Nevertheless, speculative construction (sometimes referred to as a merchant plant) in advance of electric market agreements has occurred in the past.

- Sites developed in phases will not necessarily consist of the same turbine model throughout the site, and portions of the site may be owned and operated by more than one business entity.[28]

- Future sites are likely to take advantage of state-of-the-art wind turbine technology, leading to larger and taller but fewer turbines at a given site.

- It is possible that existing sites will expand into less-ideal areas that cannot, at this time, be economically farmed for wind energy by state-of-the-art turbine technologies.

- Sites may be repowered by replacing original turbines with technologically advanced models.[29]

- Modular construction of turbines will allow for their customization to address site-specific characteristics. Modular construction, together with sophisticated SCADA systems, now make it technically feasible for future farms to consist of various models of turbines operating at different elevations on the basis of site-specific wind regime characteristics.

- Site development strategies will take fullest advantage of economies of scale. Activities will be grouped by type (e.g., foundations for all planned turbines will be installed over the same period), thereby simplifying logistics.

- Although the majority of wind turbine construction will still occur at the manufacturer's facility, larger turbines, longer and more slender adaptive blades, and taller towers will impose unique problems related to the transportation of those components and may result in additional subassembly work being conducted on site during site construction.

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[28] The Foote Creek Rim site, located near Arlington, Wyoming, is an example of one possible wind farm development scenario. This project, which was initiated on BLM-administered land and has subsequently been expanded to adjacent non-BLM-administered lands, represents one of the most ideal wind regimes in existence, with average wind speeds in excess of 23 mph (37 km/h). Four separate wind farms have been developed by two separate developers, delivering electric power to three separate utilities. The first farm, completed in April 1999, involved the erection of sixty-nine 600-kW turbines built by Mitsubishi (Model 600) and distributed over a land area of 2,156 acres (872 ha). The footprints of the turbines, control buildings, and other structures make up less than 1% of the land area in the parcel. A second farm completed in June 1999 added an additional three Mitsubishi turbines and 1.8 MW of generating capacity. A third farm, also completed in June 1999, added 33 NEG Micon turbines, representing a capacity of 24.8 MW. A final phase of development, completed in October 2000, involved an additional 16.8 MW of capacity from an additional 28 Mitsubishi Model 600 turbines. The remainder of the parcel continues to be used for ranching, as was the case before the wind farm was constructed.

[29] Repowering is already occurring. Many of the wind farms constructed in California in the early 1980s have been repowered. See the attachment to this appendix.

- The use of innovative, self-erecting towers constructed of lightweight composite materials may dramatically minimize problems related to transportation logistics and site development times and costs. Reduced transportation requirements may expand the array of candidate sites to some that were previously excluded because of access difficulties.

- Equipment manufacturers can be expected to conform to international quality standards for manufacturing and operation (and to analogous U.S. standards as they are promulgated) as a way of maintaining market competitiveness. This conformance to standards will, in turn, lead to higher quality and greater reliability of major turbine components. Maintenance intervals are expected to increase as maintenance procedures become more regimented and are based on empirically derived isochronal factors rather than elapsed time.

- Sophisticated SCADA systems will allow wind turbines at a given site to operate independently of one another, enabling the economical development of sites with different wind regimes throughout.

- It will become increasingly feasible for wind farms to include ancillary technologies, such as battery charging and elevated water storage, which will allow for the delayed delivery of wind-generated electricity to the transmission grid.

- The expanded capabilities and operating ranges of turbines will allow economical harvesting of wind energy at sites with Class 3 wind regimes.

D.11 REFERENCES FOR APPENDIX D

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Attachment to Appendix D:

Commercial Wind Energy Projects (as of January 2004)

Data on commercial wind energy projects in the western states that are within the scope of this programmatic environmental impact statement (PEIS) are displayed in the tables below. The American Wind Energy Association (AWEA) compiles and maintains all of the data displayed below. All data presented are current as of January 14, 2004. All data are accessible electronically from the AWEA Web site at http://www.awea.org/projects/index.html. Data presented in the tables below are updated quarterly by the AWEA.

The Bureau of Land Management (BLM) cannot guarantee the completeness or accuracy of these listings. Submission by wind farm developers or operators of project information to AWEA for inclusion in these listings is voluntary.

California

Major CA Wind Energy Resource Areas

Existing Project or Area	MW Installed*	Annual Energy Output (Yr of Est)	Power Purchaser/ User	Turbines
1. Altamont Pass	548.32	637 M kWh (1998)	Pacific Gas & Electric	Variety
2. Pacheco Pass	16.0	22.3 M kWh (1998)	Pacific Gas & Electric	Variety
3. San Gorgonio Pass	614.94	805 M kWh (1998)	So. California Edison	Variety
4. Solano County	176.16	N.A.	S.M.U.D	Kenetech & Vestas
	60.0	97.1 M kWh (1998)	Pacific Gas & Electric	U.S. Wind- power 100
5. Tehachapi	605.72	1.2 B kWh (1998)	So. California Edison	Variety
Others	0.675	N.A.	U.S. Navy	NEG-Micon

Wind Energy Projects in California

Project Name	Owner	Year	MW	Power Purchaser	Turbines / Units
Altamont Pass					
1985 Zond Windsystem Partners Series 85C	GE Wind	1985	18.0	PG&E	Vestas V-17 (200)
Venture Wind (old Los Vaqueros)	SeaWest	mid-1980's	2.89	PG&E	Polenko/ Wind-matic (38)
Altech Energy, Ltd	SeaWest	1981-1995	5.76	PG&E	Enertech (144)
C.W.E.S.	SeaWest	1981-1995	1.32	PG&E	Enertech (24)
SeaWest Energy Group (a)	SeaWest	1981-1995	0.065	PG&E	Micon (1)

		1995			(170)
Zond-PanAero Windsystems	GE Wind	1981-1995	29.9	So Cal Ed	Vestas V-15 (460)
Whitewater Hill (San Gorgonio Farms)	San Gorgonio Farms	1984 - 1994	31.0	So Cal Ed	DWT 400 (35), Bonus 120 (56), Vestas 500 (5), Bonus 65 (85)
Dutch Pacific	Dutch Pacific, LLC	1994	10.0	So Cal Ed	NedWind (20)
Karen Avenue (San Gorgonio Farms)	San Gorgonio Farms	1995	3.0	So Cal Ed	Vestas (6)
East Winds (formerly Altech III)	Nichimen America	1997	4.2	So Cal Ed	NEG-Micon (7)
Invest I-IX Project Web Site	K/S Whitewater	1999	10.0	So Cal Ed	Nordex (10)
Pacific West I	PacifiCorp	1999	2.1	SCE - Green Mt. Energy	NEG Micon - (3)
Cabazon (Re-power)	GE Wind	1999	39.75	So Cal Ed	Zond Z-750 (53)
Westwind (Re-power)	Cinergy & Caithness	May 1999	46.5	So Cal Ed	NEG Micon Project Info
GE Wind / Earth Smart/ Green Power	GE Wind	June 1999	16.5	Electricity Marketers	Zond Z-50 (22)
Westwind-Pacificorp (Re-Power)	Pacificorp/ GMER	May 1999	1.5	SCE - Green Mt. Energy	NEG-Micon (2)
Mountain View Power Partners II	PGE-NEG	Oct 2001	22.20	PG&E	Mitsubishi MWT600 (37)
Mountain View Power Partners I	PGE-NEG	Oct 2001	44.40	PG&E	Mitsubishi MWT600 (74)
Whitewater Hill	Shell Wind Energy	Dec 2002	61.50	Dept. of Water Resources	GE Wind Energy 1500 (41)
Cabazon	Shell Wind Energy	Dec 2002	40.92	Dept of Water Resources	Vestas V-47 (62)
Karen Avenue II	San Gorgonio Farms	June 2003	4.5	So Cal Ed	GE Wind Energy 1500 (3)
Mountain View III	San Diego Gas & Electric	4th Q 2003	22.44	San Diego Gas & Electric	Vestas 650 (34)

Solano County

Solano County/ Kenetech	NA	1985	60.0	PG&E	U.S. Windpower (600)
Sacramento Municipal Utility District (SMUD)	SMUD	1994	3.6	Sac Mun Utility District	Kenetech (12)
SMUD	SMUD	1999	0.66	Sac Mun Utility District	Vestas (1)
SMUD	SMUD	2003	9.9	Sac Mun Utility District	Vestas 660kW (15)
High Winds	SMUD	2003	162	Sac Mun Utility District	Vestas 1.8 MW (90)

Tehachapi

Zond Systems	GE Wind	1986	0.2	So Cal Ed.	Vestas (1)
Victory Gardens, Phase IV	GE Wind	1990	22.05	So Cal Ed.	Vestas V-27 (98)
Sky River	GE Wind	1993	76.95	So Cal Ed.	Vestas V-27 (342)
Oak Creek Energy Systems	Oak Creek Energy Systems	2002	0.8	So Cal Ed.	NEG Micon (1)
Oak Creek Energy Systems	Oak Creek Energy Systems	1981-1995	3.45	So Cal Ed.	Micon (36)
AB Energy	NA	1981-1995	7.0	So Cal Ed.	Vestas V27 (31)
Calwind Resources	NA	1981-1995	14.1	So Cal Ed.	Bonus (217)
Calwind Resources	NA	1981-1995	8.7	So Cal Ed.	Nordtank (134)
Coram Energy Group	NA	1981-1995	1.9	So Cal Ed.	Aeroman (47)
Coram Energy Group	NA	1981-1995	4.0	So Cal Ed.	Aeroman (100)
Coram Energy Group	NA	1981-1995	6.8	So Cal Ed.	Aeroman / Tacke (110 / 4)
Mogul Energy	NA	1981-1995	4.0	So Cal Ed.	Mitsubishi (8)
Mohave 3, 4, 5	Tomen/ FPL	1981-1995	75.0	So Cal Ed.	Mitsubishi (300)
Mohave 16, 17, 18	Tomen/ FPL	1981-1995	85.0	So Cal Ed.	Mitsubishi (340)
Windridge	NA	1981-1995	2.34	So Cal Ed.	Windmatic (36)
Victory Gardens I & IV	NA	1981-1995	1.0	So Cal Ed.	Vestas (2)
Cannon	NA	1981-1995	13.46	So Cal Ed.	Micon, Vestas (8, 28)
Cannon (Various)	NA	1981-1995	4.54	So Cal Ed.	Micon, Vestas (42)
Ridgetop Energy	NA	1981-1995	32.6	So Cal Ed.	Nordtank, Micon (329)
Zond Systems	GE Wind	1982-1987	23.99	So Cal Ed.	Vestas (369)
Zond Systems	GE Wind	1982-1987	64.0	So Cal Ed.	Vestas (711)
Windland (Boxcar II)	Windland, Inc.	Mid-1980's	14.3	So Cal Ed.	Various (141)
Oak Creek Energy Systems	Oak Creek Energy	2002	1.35	So, Cal Ed	NEG Micon (1)

Oak Creek Phase 1 (ON Energy)	Nichimen & Oak Creek Energy	Sept 1997	4.2	So Cal Ed.	NEG Micon (7)
Oak Creek Phase 2A (Re-power)	Oak Creek Energy	June 1999	1.6	So Cal Ed	NEG Micon (2)
Pacific Crest	FPL Energy	Jun 1999	45.54	So Cal Ed	Vestas (69)
Oak Creek Wind Power Phase 2 (Repower)	Caithness	June 1999	23.1	So Cal Ed	NEG Micon-700 Project Info (33)
Cameron Ridge (Re-power)	FPL & Caithness	Mar 1999	56.0	So Cal Ed	NEG Micon (80) Project Info
Victory Gardens (Repower)	Enron Wind Corp.	Jun 1999	6.75	So Cal Ed	Zond Z-50 (9)

Others

U.S. Navy/ NEG Micon San Clemente Island	U.S. Navy	1998	0.675	U.S. Navy	NEG Micon (3)
Los Angeles Co.	Wind Turbine Company	2001	0.50	Southern Cal Ed.	WTC (1)

Planned Projects in California

Utility/Developer (Project)	Location	Status	MW Cap	Online date/ Turbine
PG&E/SeaWest (Venture Pacific)	Altamont Pass	Pending	25.6	2004 Mitsubishi
FPL/Green Ridge Power	Altamont Pass	Proposed Re-power	110.0	2004 NEG Micon - 700
Indigenous Global Development Corp.	Contra Costa	Proposed	22.50	NA / TBD
Pacific Ind Elec (San Clemente Is.)	San Clemente Is.	Under Dev	0.75	2004 NEG Micon
Mark Technologies (Alta Mesa IV)	San Gorgonio	Under Dev.	40.3	2004 Vestas - 660 kW
SMUD (Solano Wind Project - Phase I)	Solano	Under Development	9.24	2004 Vestas V-47
GE Wind (Victory Garden)	Tehachapi	Proposed	30.0	2004 GE Wind
Oak Creek Energy Sys (Jawbone)	Tehachapi	Proposed	52.5	2004

+ Uncertain completion dates

Colorado

Wind Energy Development

Project or Area	Owner	Date Online	MW	Power Purchaser/User	Turbines / Units
1. Ponnequin (EIU) (Phase I)	K/S Ponnequin WindSource & Energy Resources	Jan 1999	5.1	PSCo	NEG Micon (7)
1. Ponnequin (PSCo) Project Info	PSCo	Feb-June 1999	16.5	PSCo	NEG Micon (22)
1. Ponnequin (Phase III)	New Century (Xcel)	2001	9.9	New Century (Xcel)	Vestas (15)
Peetz Table Wind Farm	New Century (Xcel)	Sept 2001	29.7	New Century (Xcel)	NEG Micon (33)
Colorado Green, Lamar (Prowers County)	Xcel Energy / GE Wind Wind Corp.	Dec 2003	162.0	Xcel	GE Wind 1500 (108)

New Wind Projects in Colorado

Utility/Developer (Project)	Location	Status	MW Capacity	On Line By/ Turbines
None				

Idaho

Wind Energy Development

Existing Project or Area	Owner	Date Online	MW	Power Purchaser/ User	Turbines/ Units
Boise	Bob Lewandowski	2003	0.216	NA	108 (2)

Planned Wind Projects in Idaho

Utility/Developer (Project)	Location	Status	MW Capacity	On Line By / Turbines
None				

Montana

Wind Energy Development

Existing Project or Area	Owner	Date Online	MW	Power Purchaser/ User	Turbine
Blackfeet Reservation	Blackfeet Nation	1996	0.1	Glacier Electric Cooperative	Vestas V-17 (1)

New Wind Projects in Montana

Utility/Developer (Project)	Location	Status	MW Capacity	On Line / Turbine
Assiniboine & Sioux Tribes / Montana-Dakota Utilities (Fort Peck Reservation Wind Project	Fort Peck Res/ Poplar MT	Under Dev.	0.66	2004/ Vestas V-47 660kW

Nevada

Wind Energy Development

Existing Project or Area	MW Installed*	Annual Energy Output (Yr of Est)	Power Purchaser/ User

None

New Wind Projects in Nevada

Utility/Developer (Project)	Location	Status	MW Capacity	On Line By/ Turbine
Global Renewable Energy Partners & BP Capital (Power Star) (Table Mountain)	Near Primm in Sandy Valley	Proposed	105.0	2004 / NEG Micon
Cielo Wind Power (Desert Queen Wind Ranch)	Clark County	Proposed	60.0	2005
Global Renewable Energy Partners (Ely Wind LLC)	White Pine County	Proposed	50.0	2005 / NEG Micon

New Mexico

Wind Energy Development

Existing Project or Area	Owner	Date Online	MW	Power Purchaser/ User	Wind Turbines
1. Curry County (Llano Estacado Wind Ranch at Texaco)		June 1999	0.66	Excel	Vestas V-48 (1)
SW Public Service (Clovis)	Texas Wind Power	June 1999	0.66	Southwestern Public Service	Vestas V-47
New Mexico Wind Energy Center	**FPL Energy**	2003	**204**	Public Service of New Mexico	GE Wind 1500 (136)
Llano Estacado Wind Ranch	**Cielo Wind Power**	4th Q 2004	**1.32**	PS of New Mexico	Vestas 660 kW (2)

New Wind Projects in New Mexico

Utility/Developer (Project)	Location	Status	MW Capacity	On Line By

None

Oregon

Wind Energy Development

Existing Project or Area	Owner	Date Online	MW	Power Purchaser/ User	Turbines/ Units
1. Vansycle Ridge (Helix, OR)	FPL Energy	Oct 1998	25.1	Portland General Electric	Vestas V-47 (38)
Condon Wind Project Phase I (Gilliam County)	TBA	Dec 2001	24.6	BPA	Mitsubishi MWT600 (41)
Klondike (Wasco)	Northwest Wind Power	Dec 2001	24.0	Northwest Wind Power	Enron 1.5MW (16)
Stateline Wind Project, (Umatilla)	FPL Energy; Vansycle	Dec 2001	83.16	PacifiCorp	Vestas V-47 (127)
Condon Wind Project Phase II (Gilliam County)	TBA	Dec 2002	25.2	Bonneville Power Administration	Mitsubishi MWT600 (42)
Stateline (Orphans)	FPL Energy Vansycle LLC	2002	37	NA	Vestas V47 (55)
Combine Hills	PacificCorp/ Eurus	Dec 2003	41.0	PacificCorp	Mitsubishi 1000 (41)

New Wind Projects

Utility/Developer (Project)	Location	Status	MW Capacity	On Line By / Turbines

None

Utah

Wind Energy Development

Existing Project or Area	Owner	Date Online	MW	Power Purchaser/ User	Wind Turbine/ Units
Camp Williams, Riverton	U.S. Gov't	May 2000	0.225		NEG Micon / (1)

New Wind Projects in Utah

Utility/Developer (Project)	Location	Status	MW Capacity	On Line By / Turbine

None

Washington State

Wind Energy Development

Existing Project or Area	Owner	Date Online	MW	Power Purchaser/ User	Turbines/ (Units)
Stateline Wind Project, Phase I (Walla Walla)	FPL Energy, Vansycle	Dec 2001	180.2	PacifiCorp	Vestas V-47 (273)
Nine Canyon Wind Farm	Energy Northwest	Sep 2002	48.0	Public Power Members of Energy Northwest	Bonus 1300 (37)
Walla Walla County	Stateline Wind	2002	39.6	NA	NA
Nine Canyon Phase II	Energy Northwest	4th Q 2003	15.6	Energy Northwest	Bonus 1300 (12)

New Wind Projects in Washington State

Utility/Developer (Project)	Location	Status	MW Capacity	On Line By
BPA / Pacific Winds (Maiden Wind Farm)	Benton & Yakima Co. near Presser	Proposed	150.0	2004
BPA / Pacific Winds (Horse Heaven Hills)	Benton Co.	Proposed	150.0	2004
Zilkha Renewable Energy (TBD)	Near Ellensburg / Kittitas County	Proposed	100.0	2004
BPA / SeaWest Wind Power (Roosevelt)	Klickitat County	Speculative	150.0	2004
BPA / SeaWest Wind Power (Six Prong)	Klickitat County	Speculative	150.0	2004
BPA / SeaWest Wind Power (Waitsburg)	Walla Walla / Columbia	Speculative	100.0	2004
BPA / Columbia Windpower (Columbia Wind Ranch)	Klickitat Co.	Speculative	80.0	2004

Wyoming

Wind Energy Development

Existing Project or Area	Owner	Date Online	MW	Power Purchaser/ User	Turbines/ Units
Medicine Bow	PRPA+	1996	0.065	PRPA	Nordtank (1)
1. Medicine Bow, WY	PRPA	1998	1.2	PRPA	Vestas (2)
1. Foote Creek Rim - I (Carbon Co.)	Pacificorp, Eugene Water & Elec.	April 1999	41.4	Pacificorp, EWEB	Mitsubishi (69)
1. Foote Creek Rim - II (Carbon Co.)	Cinergy Global (Part Interest)	June 1999	1.8	BPA	Mitsubishi (3)
1. Foote Creek Rim - III	Cinergy Global	June	24.75	Public Service	NEG Micon

(Carbon Co.)	Power	1999		Co of Colorado	(33) Project Info
1. Foot Creek Rim - IV (Carbon Co.)	Cinergy Global Power	Oct 2000	16.8	BPA	Mitsubishi 600 (28)
1. Medicine Bow	PRPA	Oct 1999	3.3	PRPA	Vestas V-47 (5)
1. Medicine Bow	PRPA	July 2000	1.32	PRPA	Vestas V-47 (2)
Arlington, Carbon Co. (Rock River I)	Shell Renewables	Oct 2001	50.0	PacifiCorp	Mitsubishi MWT (50)
Evanston	FPL Energy/Orion Energy	4th Q 2003	144.0	PPM Energy	Vestas 1800 (80)

+ Platte River Power Authority

New Wind Projects in Wyoming

Utility/Developer (Project)	Location	Status	MW Capacity	On Line By / Turbines
None				

Notes:
No commercial wind energy projects are operational or planned for Arizona.
Only those wind energy projects that interconnect to the electric transmission system are listed.
Unless otherwise specified, all data are current as of January 14, 2004.

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APPENDIX E:

FEDERAL AND STATE REGULATORY REQUIREMENTS POTENTIALLY APPLICABLE TO WIND ENERGY PROJECTS

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APPENDIX E:

FEDERAL AND STATE REGULATORY REQUIREMENTS POTENTIALLY APPLICABLE TO WIND ENERGY PROJECTS

The tables that follow list the major federal and state laws, Executive Orders, and other compliance instruments that establish permits, approvals, or consultations that may apply to the construction and operation of a wind energy project on Bureau of Land Management (BLM)-administered lands. The general application of these federal and state authorities and other regulatory considerations associated with such construction and operation are discussed in Chapter 3.

The tables are divided into general environmental impact categories. The citations in the tables are those of the general statutory authority that governs the indicated category of activities to be undertaken under the proposed action and alternatives. Under such statutory authority, the lead federal or state agency may have promulgated implementing regulations that set forth the detailed procedures for permitting and compliance.

Definitions of abbreviations used in the tables are provided here.

ARS	*Arizona Revised Statutes*
CRS	*Colorado Revised Statues*
CFR	*Code of Federal Regulations*
IC	*Idaho Code*
MCA	*Montana Code Annotated*
NMSA	*New Mexico Statutes Annotated*
NRS	*Nevada Revised Statutes*
ORS	*Oregon Revised Statutes*
RCW	*Revised Code of Washington*
UCA	*Utah Code Annotated*
USC	*United States Code*
WS	*Wyoming Statutes*

TABLE E-1 Wind Energy Project Siting

Authority	Citation
Federal	No primary statutory authority
Arizona	No primary statutory authority
California	• Public Resources Code, Division 13, § 21000 et seq. • Public Resources Code, Division 15, Chapter 6, Power Facility and Site Certification, § 25500 et seq. • Public Resources Code, Division 15, Chapter 8, § 25743, Development of new in-state renewable electricity generation facilities • Government Code, Division 1, Chapter 4, Article 2.11, Wind Energy, § 65892.13 et seq.
Colorado	Local government regulation — location, construction, or improvement of major electrical or natural gas facilities — legislative declaration (CRS 29-20-108)
Idaho	No primary statutory authority
Montana	• Montana Environmental Policy Act (MCA 75-1-101 et seq.) • Major Facility Siting (MCA 75-20-101 et seq.) • Wind Energy Easement (MCA 70-17-303)
Nevada	Construction of Utility Facilities; Utility Environmental Protection Act (NRS 704.820 et seq.)
New Mexico	No primary statutory authority
Oregon	Regulation of Energy Facilities, Energy Facility Siting Council (ORS 469.300-469.520)
Utah	Electrical Facility Review Board Act (UCA 54-14-10 et seq.)
Washington	• State Environmental Policy Act (RCW 43.21 C.010 et seq.) • Washington Energy Facility Site Evaluation Council (RCW 80.50.010 et seq.)
Wyoming	Industrial Development Information and Siting Act (WS 35-12-101 et seq.)

TABLE E-2 Land Use

Authority	Citation
Federal	• Federal Land Policy and Management Act of 1976 (43 USC 1701 et seq.) • BLM Right-of-Way Regulation (43 CFR 2800) • Coastal Zone Management Act (16 USC 1451 et seq.) • Coastal Zone Act Reauthorization Amendments of 1990 (16 USC 1456 (c)(3)(A)) • Wild and Scenic Rivers Act (16 USC 1271 et seq.) • Farmland Protection and Policy Act (7 USC 4201 et seq.) • Soil and Water Conservation Act of 1977 (16 USC 2001 et seq.) • Structures Interfering with Air Commerce (49 USC 44718) • Objects Affecting Navigable Airspace (14 CFR 77) • Federal Aviation Administration, Advisory Circular 70/7460-2K, March 1, 2000 • Oregon and California Grant Lands Act of 1937 (43 USC 1181 a, b, d-f) • The Northwest Forest Plan
Arizona	• No primary statutory authority
California	• Public Resources Code, Division 5, Wild and Scenic Rivers Act, § 5093.50-5093.70 • Public Resources Code, Division 25, Coastal Resources and Energy Assistance, § 35000 et seq.
Colorado	Areas and Activities of State Interest (CRS 24-65.101 et seq.; CRS 24-65.1-101)
Idaho	Local Land Use Planning Act (IC 67-6501 et seq.)
Montana	• Land Use Regulations (MCA 76-15-701 et seq.) • Wild and Scenic Resources (MCA 76-12-101 et seq.) • Timber Resources (MCA 76-13-101 et seq.) • Rangeland Resources (MCA 76-14-101 et seq.)
Nevada	Conservation; Regulations for Use of Land (NRS 548.410 et seq.)
New Mexico	No primary statutory authority
Oregon	Comprehensive Land Use Planning Coordination, Statewide Planning Goals and Guidelines (including Oregon Ocean-Coastal Management Program; Agricultural Lands; Open Spaces, Scenic and Historic Areas, and Natural Resources; and Air, Water and Land Resources) (ORS 197.005 et seq.)
Utah	No primary statutory authority
Washington	• Shoreline Management Act of 1971 (RCW 90.58.010 et seq.) • Wetland Mitigation Banking (RCW 90.84.005 et seq.)
Wyoming	Wyoming Environmental Quality Act (WS 35-11-101 et seq.)

TABLE E-3 Floodplains and Wetlands

Authority	Citation
Federal	• Clean Water Act (33 USC 1344) • Rivers and Harbors Act of 1899 (33 USC 401 et seq.) • Executive Order 11988, "Floodplain Management," May 21, 1977 • Executive Order 11990, "Protection of Wetlands," May 24, 1977
Arizona	Floodplain delineation; regulation of use (ARS 48-3609)
California	• Public Resources Code, Chapter 7, Wetlands Preservation (Keene-Nejedly California Wetlands Preservation Act), § 5810 et seq. • Water Code, Division 5, Cobey-Alquist Flood Plain Management Act, § 8400 et seq.
Colorado	Areas and Activities of State Interest (CRS 24-65.1-101 et seq.; CRS 24-65.1-202) Local Government Land Use Control Enabling Act (CRS 29-20-104)
Idaho	Local governments may adopt floodplain zoning ordinances (IC 46-1022)
Montana	• Aquatic Ecosystem Protections (MCA 75-7-101 et seq.) • Flood Plain and Floodway Management (MCA 76-5-101 et seq.)
Nevada	Planning and Zoning, Contents of Regional Plans (NRS 278.0274)
New Mexico	Powers of Municipalities, Additional County and Municipal Powers; Flood and Mudslides Hazard Areas; Floodplain Permits; Land Use Control; Jurisdiction; Agreement (3-18-7(C) NMSA 1978)
Oregon	• Wetlands Conservation (ORS 196.600 et seq.) • Removal of Material and Fill (ORS 196.795)
Utah	Quality Growth Act of 1999 (UCA 11-38-101 et seq.)
Washington	• Wetlands Mitigation Banking (RCW 90.84.005 et seq.) • Floodplain Management (Chapter 86.16, RCW)
Wyoming	Water Quality (WS 35-11-301 et seq.)

TABLE E-4 Water Bodies and Wastewater

Authority	Citation
Federal	Clean Water Act (33 USC 1251 et seq.)
Arizona	Water Quality Control (ARS 49-201 et seq.)
California	Water Code, Division 7, Water Quality, § 13000 et seq.
Colorado	Water Quality Control (CRS 25-8-101 et seq.)
Idaho	Water Quality (IC 39-3601 et seq.)
Montana	Water Quality (MCA 75-5-101 et seq.)
Nevada	Water Controls; Water Pollution Controls (NRS 445A.300 et seq.)
New Mexico	Water Quality (74-6-1 NMSA 1978 et seq.)
Oregon	• Water Quality, Water Pollution Control (ORS 468B.005 et seq.) • Sewage Treatment and Disposal Systems (ORS 454.010 et seq.)
Utah	Water Quality Act (UCA 19-5-101 et seq.)
Washington	• Domestic Wastewater Treatment Plants — Operators (RCW 70.95B010 et seq.) • On-site Sewage Disposal Systems (RCW 70.118.010 et seq.) • Water Pollution Control (RCW 90.48.010 et seq.)
Wyoming	Water Quality (WS 35-11-301 et seq.)

TABLE E-5 Groundwater, Drinking Water, and Water Rights

Authority	Citation
Federal	Safe Drinking Water Act (42 USC 300(f) et seq.)
Arizona	Water Quality Control (ARS 49-201 et seq., 49-241 et seq., 49-255 et seq., 49-351 et seq., 45-151 et seq.)
California	• Health and Safety Code, Division 104, California Safe Drinking Water Act, § 116270 • Water Code, Division 2, Water, § 1000 et seq.
Colorado	• Water Quality Control (CRS 25-8-101 et seq.) • Water Rights and Irrigation (CRS 37-92-501 et seq.)
Idaho	• Groundwater Recharge (IC 42-4201) • Irrigation and Drainage — Water Rights and Reclamation (IC 42-101, et seq.) • Domestic Water and Ice (IC 37-2102) • State Policy on Environmental Protection (IC 39-102)
Montana	• Water Use (MCA 85-2-101 et seq.) • Public Water Supplies, Distribution, and Treatment (MCA 75-6-101 et seq.)
Nevada	• Underground Water and Wells (NRS 534.010 et seq.) • Water Controls; Public Water Systems (NRS 445A.800 et seq.)
New Mexico	Compliance with the Federal Safe Drinking Water Act (74-1-12 NMSA 1978)
Oregon	• Oregon Drinking Water Quality Act of 1981 (ORS 448.115-448.990) • Water Quality, Pollution Prevention Control (Groundwater) (ORS 468B.150 et. seq.) • Water Resources Administration (ORS 536.220 et seq.)
Utah	• Safe Drinking Water Act (UCA 19-4-101 et seq.) • Water & Irrigation (UCA 73-1-1 et seq.)
Washington	• Water Code (RCW 90.03.005 et seq.) • Regulation of Public Ground Water (RCW 90.44.020 et seq.)
Wyoming	• Water Rights; Administration and Control (WS 41-3-101 et seq.) • Water Quality (WS 35-11-301 et seq.)

TABLE E-6 Source Water Protection

Authority	Citation
Federal	Safe Drinking Water Act, Protection of Underground Sources of Drinking Water (42 USC 300h-7)
Arizona	Aquifer Protection Permits (ARS 49-241 et seq.)
California	• Water Supply, Division 104, § 116975 et seq. • Water Code, Division 7, § 13751 et seq. • Areas and Activities of State Interest (CRS 24-65.1-204)
Colorado	Water Quality Control (CRS 25-8-101 et seq.)
Idaho	Groundwater Recharge (IC 42-4201)
Montana	Montana Wellhead Protection Program (MCA 75-6-120)
Nevada	Underground Water and Wells (NRS 534.010 et seq.)
New Mexico	No primary statutory authority
Oregon	Water Pollution Control (Groundwater) (ORS 468B.167 et seq.)
Utah	Utah Water Quality Act (UCA 19-5-101 et seq.)
Washington	No primary statutory authority
Wyoming	Protection of Public Water Supply (WS 35-4-201 et seq.)

TABLE E-7 Cultural Resources

Authority	Citation
Federal	• Executive Order 13007, "Indian Sacred Sites," May 24, 1996 • Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments," Nov. 9, 2000 • Native American Graves Protection and Repatriation Act (25 USC 3001) • American Indian Religious Freedom Act (42 USC 1996) • Archeological Resources Protection Act (16 USC 470(aa) et seq.) • Archaeological and Historic Preservation Act (16 USC 469a et seq.) • Antiquities Act (16 USC 431 et seq.) • National Historic Preservation Act (16 USC 470 et seq.) • Theft of Government Property (62 Stat. 764; 19 USC 1361) • Executive Order 11593, "Protection and Enhancement of the Cultural Environment," May 15, 1971
Arizona	• Duties, board; partnership fund; state historic preservation officer (ARS 41-511.04) • Arizona Historical Society; powers; officers; duties of board of directors (ARS 41-821 et seq.) • Historic Preservation (ARS 41-861 et seq.) • Archeological Discoveries (ARS 41-841 et seq.)
California	Public Resources Code, Division 5, Historical Resources, § 5020 et seq.
Colorado	• Historical, Prehistorical, and Archeological Resources (CRS 24-80-401 et seq.) • Unmarked Human Graves (CRS 24-80-1302 et seq.)
Idaho	• Idaho Archaeological Survey (IC 33-3901 et seq.) • Protection of Graves (IC 27-501 et seq.) • Preservation of Historic Sites (IC 67-4601 et seq.)
Montana	Antiquities (MCA 22-3-101)
Nevada	Historic Preservation and Archeology (NRS 383.011 et seq.)
New Mexico	Cultural Properties Act (18-6-3 NMSA 1978)
Oregon	• Historical Properties (ORS 358.475 et seq.) • Indian Graves and Protected Objects (ORS 97.740 et seq.)
Utah	• History Development (UCA 9-8-102 et seq.) • Native American Grave Protection and Repatriation Act (UCA 9-9-401 et seq.)
Washington	• Archaeological Sites and Resources (Chapter 27.53, RCW) • Indian Graves and Records (Chapter 27.44, RCW) • State Historical Societies — Historic Preservation (Chapter 27.34, RCW)
Wyoming	Antiquities Act (WS 36-1-114 through 36-1-116)

TABLE E-8 Wildlife

Authority	Citation
Federal	• Bald and Golden Eagle Protection Act (16 USC 668) • Migratory Bird Treaty Act (16 USC § 703) • Endangered Species Act (16 USC 1531 et seq.) • Wild Free-Roaming Horse and Burro Act of 1971 (Public Law 92-195) • Executive Order 13112, "Invasive Species," February 3, 1999 • Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds," February 10, 2001
Arizona	• Powers and Duties (ARS 17-231 et seq.) • Taking and Handling of Wildlife (ARS 17-301 et seq.) • Wildlife Habitat Protection (ARS 17-451)
California	• Fish and Game Code, Division 3, Chapter 1.5, Endangered Species, § 2050 et seq. • Fish and Game Code, Division 5, Protected Reptiles and Amphibians, § 5000 et seq.
Colorado	• Non-game, Endangered, or Threatened Species Conservation Act (CRS 33-2-101 et seq.) • Migratory Birds — Possession of Raptors — Reciprocal Agreements — Reports to General Assembly (CRS 33-1-115) • Colorado Natural Areas (CRS 33-33-101 et seq.) • Protection of Fishing Streams (CRS 33-5-101 et seq.)
Idaho	Species Conservation (IC 36-2401 et seq.)
Montana	Wildlife Protection (MCA 87-5-101 et seq.)
Nevada	Wildlife (NRS 501.002 et seq.)
New Mexico	• Wildlife Conservation Act (17-2-46 NMSA 1978 • Endangered Plant Species (75-6-1 NMSA 1978) • Habitat Protection (17-6-1 NMSA 1978 et seq.)
Oregon	• Threatened and Endangered Wildlife Species (ORS 496.171 et seq.) • Wildflowers; Threatened and Endangered Plants (ORS 564.010 et seq.) • General Protective Regulations, Commercial Fishing and Fisheries, Fish Passage; Fishways; Screening Devices; Hatcheries near Dams (ORS 509.580 et seq.) • Hunting, Angling, and Trapping Regulations; Wildlife Protective Provisions (ORS 498.002 et seq.)
Utah	Wildlife Resources Code of Utah (UCA 23-13-1 et seq.)
Washington	Protection of Bald Eagles and Their Habitats (RCW 77.12.650-655)
Wyoming	• Bird and Animal Provisions (WS 23-3-101 et seq.) • Predatory Animals; Control Generally (WS 11-6-101 et seq.)

TABLE E-9 Air Quality

Authority	Citation
Federal	Clean Air Act (42 USC 7401 et seq.)
Arizona	Air Quality (ARS 49-401 et seq.)
California	Health and Safety Code, Division 26, Air Resources, § 39000 et seq.
Colorado	Air Quality Control (CRS 25-7-101 et seq.)
Idaho	• Registration of Persons Engaged in Operations or Construction Where Air Pollution Is a Factor (IC 39-110) • Pollution Source Permits (IC 39-115) • Relationship to Federal Law (IC 39-118B)
Montana	Air Quality (MCA 75-2-101 et seq.)
Nevada	Air Pollution (NRS 445B.100 et seq.)
New Mexico	• Environmental Improvement Act (74-1-1 NMSA 1978 et seq.) • Air Quality Control Act (74-1-1 NMSA 1978 et seq.)
Oregon	Air Quality (ORS 468A.005 et seq.)
Utah	Air Conservation Act (UCA 19-2-101 et seq.)
Washington	Washington Clean Air Act (Chapter 70.94, RCW)
Wyoming	Air Quality (WS 35-11-201 et seq.)

TABLE E-10 Noise

Authority	Citation
Federal	Noise Control Act, as amended by the Quiet Communities Act (42 USC 4901 et seq.)
Arizona	No primary statutory authority
California	Health and Safety Code, Division 28, Noise Control Act, § 46000 et seq.
Colorado	Noise Abatement (CRS 25-12-101 et seq.)
Idaho	No primary statutory authority
Montana	No primary statutory authority
Nevada	Prevention of Excessive Noise (NRS 244.363)
New Mexico	No primary statutory authority
Oregon	Noise Control (ORS 467.010 et seq.)
Utah	No primary statutory authority
Washington	Noise Control (RCW 70.07.010 et seq.)
Wyoming	No primary statutory authority

TABLE E-11 Hazardous Materials

Authority	Citation
Federal	• Hazardous Materials Transportation Law (49 USC 5101-5127) • Emergency Planning and Community Right-to-Know Act of 1986, as extended to federal facilities by Executive Order 12856, August 3, 1993 • Oil Pollution Control Act (33 USC 2701 et seq.) • Pollution Prevention Act of 1990 (42 USC 13101 et seq.)
Arizona	Emergency Planning and Community Right-to-Know Act (ARS 26-341 et seq.)
California	• Health and Safety Code, Division 20, Chapter 6.11, Unified Hazardous Waste and Hazardous Materials Management and Regulatory Program, § 25404 et seq. • Health and Safety Code, Division 20, Chapter 6.6, Safe Drinking Water and Toxics Enforcement Act of 1986 (Proposition 65), § 25249.5 et seq. • Health and Safety Code, Division 20, Chapter 6.95, Hazardous Materials Release Response Plans and Inventory, § 25500 et seq.
Colorado	• Implementation of Title III of Superfund Act (CRS 24-32-2601 et seq.) • Hazardous Substances (CRS 25-5-501 et seq.)
Idaho	Hazardous Substances Emergency Response Act (IC 39-7101 et seq.)
Montana	Montana Response to Hazardous Material Incidents Act (MCA 10-3-1201 et seq.)
Nevada	Hazardous Materials; Regulation of Highly Hazardous Substances and Explosives (NRS 459.380 et seq.)
New Mexico	• Hazardous Chemicals Information Act (74-4E-1 NMSA 1978 et seq.) • Hazardous Material Transportation (74-4F-1 NMSA 1978 et seq.)
Oregon	Hazardous Substances (ORS 453.001-453.527)
Utah	No primary statutory authority
Washington	Oil and Hazardous Substance Spill Prevention and Response (RCW 90.56.005 et seq.)
Wyoming	Water Pollution from Underground Storage Tanks Corrective Action Act of 1990 (WS 35-11-1414 et seq.)

TABLE E-12 Pesticides and Noxious Weeds

Authority	Citation
Federal	• Federal Insecticide, Fungicide, and Rodenticide Act (7 USC 136 et seq.) • Noxious Weed Act of 1974 (7 USC 2801-2813), as amended by Section 15, Management of Undesirable Plants on Federal Lands 1990
Arizona	• Pesticide Contamination Prevention (ARS 49-301) • Pesticides (ARS 3-341 et seq.) • Pesticide Control (ARS 3-361 et seq.)
California	• Food and Agriculture Code, Division 7, Agricultural Chemicals, Livestock Remedies, and Commercial Feeds, § 12500 et seq. • Food and Agriculture Code, Division 4, Weeds, § 7201 et seq.
Colorado	Pesticide Act (CRS 35-9-101 et seq.)
Idaho	• Application of Fertilizers and Pesticides (IC 39-127) • Pesticides and Chemigation (IC 22-3401 et seq.) • Noxious Weeds (IC 22-2401 et seq.)
Montana	• Pesticides (MCA 80-8-101 et seq.) • Weed Control (MCA 80-7-701 et seq.)
Nevada	Control of Insects, Pests, and Noxious Weeds (NRS 555.005 et seq.)
New Mexico	Pesticide Control Act (76-4-1 NMSA 1978 et seq.)
Oregon	Pesticide Control (ORS 634.005 et seq.)
Utah	Utah Pesticide Control Act (UCA 4-14-1 et seq.)
Washington	Washington Pesticide Application Act (RCW 17.21.010 et seq.)
Wyoming	Wyoming Weed and Pest Control Act of 1973 (WS 11-5-1001 et seq.)

TABLE E-13 Solid Waste

Authority	Citation
Federal	Solid Waste Disposal Act (SWDA) (42 USC 6901 et seq.)
Arizona	Solid Waste Management (ARS 49-701 et seq.)
California	Public Resources Code, Division 30, Waste Management, § 40000 et seq.
Colorado	Solid Waste Disposal Sites and Facilities (CRS 30-20-100.5 et seq.)
Idaho	Idaho Solid Waste Facilities Act (IC 39-7401 et seq.)
Montana	Montana Solid Waste Management Act (MCA 75-10-201 et seq.)
Nevada	Sanitation; Collection and Disposal of Solid Waste (NRS 444.440 et seq.)
New Mexico	Solid Waste Act (74-9-1 NMSA 1978 et seq.)
Oregon	Solid Waste Management (ORS 459.005 et seq.)
Utah	Solid Waste Management Act (UCA 19-6-501 et seq.)
Washington	Solid Waste Management — Reduction and Recycling (RCW 70.95.010 et seq.)
Wyoming	Solid Waste Management (WS 35-11-501 et seq.)

TABLE E-14 Hazardous Waste and Polychlorinated Biphenyls (PCBs)

Authority	Citation
Federal	• Toxic Substances Control Act (15 USC 2605(e)) • Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (42 USC 6901 et seq.) and the Hazardous Solid Waste Amendments of 1984
Arizona	Hazardous Waste Disposal (ARS 49-901 et seq.)
California	Health and Safety Code, Division 20, Hazardous Waste Control, § 25100 et seq.
Colorado	Hazardous Waste (CRS 25-15-101 et seq.)
Idaho	• Hazardous Waste Management (IC 39-4401 et seq.) • PCB Waste Disposal (IC 39-6201 et seq.)
Montana	Montana Hazardous Waste Act (MCA 75-10-401 et seq.)
Nevada	Hazardous Material; Disposal of Hazardous Waste (NRS 459.400 et seq.)
New Mexico	Hazardous Waste Act (74-4-1 through 74-4-14 NMSA 1978)
Oregon	• Hazardous Waste and Hazardous Materials I (ORS 465.005 et seq.) • Hazardous Waste and Hazardous Materials II (ORS 466.005 et seq.)
Utah	Solid and Hazardous Waste Act (UCA 19-6-101 et seq.)
Washington	Hazardous Waste Management (RCW 70.105.005 et seq.)
Wyoming	Solid Waste Management (WS 35-11-503 and 35-11-516)

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APPENDIX F:

ECOREGIONS OF THE 11 WESTERN STATES AND DISTRIBUTION BY ECOREGION OF WIND ENERGY RESOURCES ON BLM-ADMINISTERED LANDS WITHIN EACH STATE

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ECOREGIONS OF THE 11 WESTERN STATES AND DISTRIBUTION BY ECOREGION OF WIND ENERGY RESOURCES ON BLM-ADMINISTERED LANDS WITHIN EACH STATE

F.1 DESCRIPTIONS OF THE ECOREGIONS

Ecoregions delineate areas that have a general similarity in their ecosystems and in the types, qualities, and quantities of their environmental resources. They are based on unique combinations of geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology (EPA 2004). Ecoregions are defined as areas having relative homogeneity in their ecological systems and their components. Factors associated with spatial differences in the quality and quantity of ecosystem components (including soils, vegetation, climate, geology, and physiography) are relatively homogeneous within an ecoregion.

A number of individuals and organizations have characterized North America on the basis of ecoregions (e.g., Omernik 1987; CEC 1997; Bailey 1997). The intent of such ecoregion classifications has been to provide a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. The ecoregion discussions presented in this programmatic environmental impact statement (PEIS) follow the Level III ecoregion classification based on Omernik (1987) and refined through collaborations among U.S. Environmental Protection Agency (EPA) regional offices, state resource management agencies, and other federal agencies (EPA 2004). The following sections provide brief descriptions of each of the Level III ecoregions that have been identified for the 11 western states in which potential wind energy development may occur on BLM-administered lands.

F.1.1 Coast Range

The Coast Range ecoregion encompasses approximately 20,600 mi^2 (53,354 km^2) along the coasts of Washington, Oregon, and northern California (Ecoregion 1, Figure F-1). This low mountain area is characterized by highly productive, rain-drenched coniferous forests, originally dominated by Sitka spruce and coastal redwood forests along the coast, with a mosaic of western red cedar, western hemlock, and seral Douglas fir in the inland areas (EPA 2002). The area is widely managed for timber production, as it is intensively logged and supports Douglas-fir plantations.

F.1.2 Puget Lowland

The Puget Lowland ecoregion (Ecoregion 2, Figure F-1) occurs wholly within the western portion of the State of Washington. This ecoregion, covering about 6,300 mi^2, is a

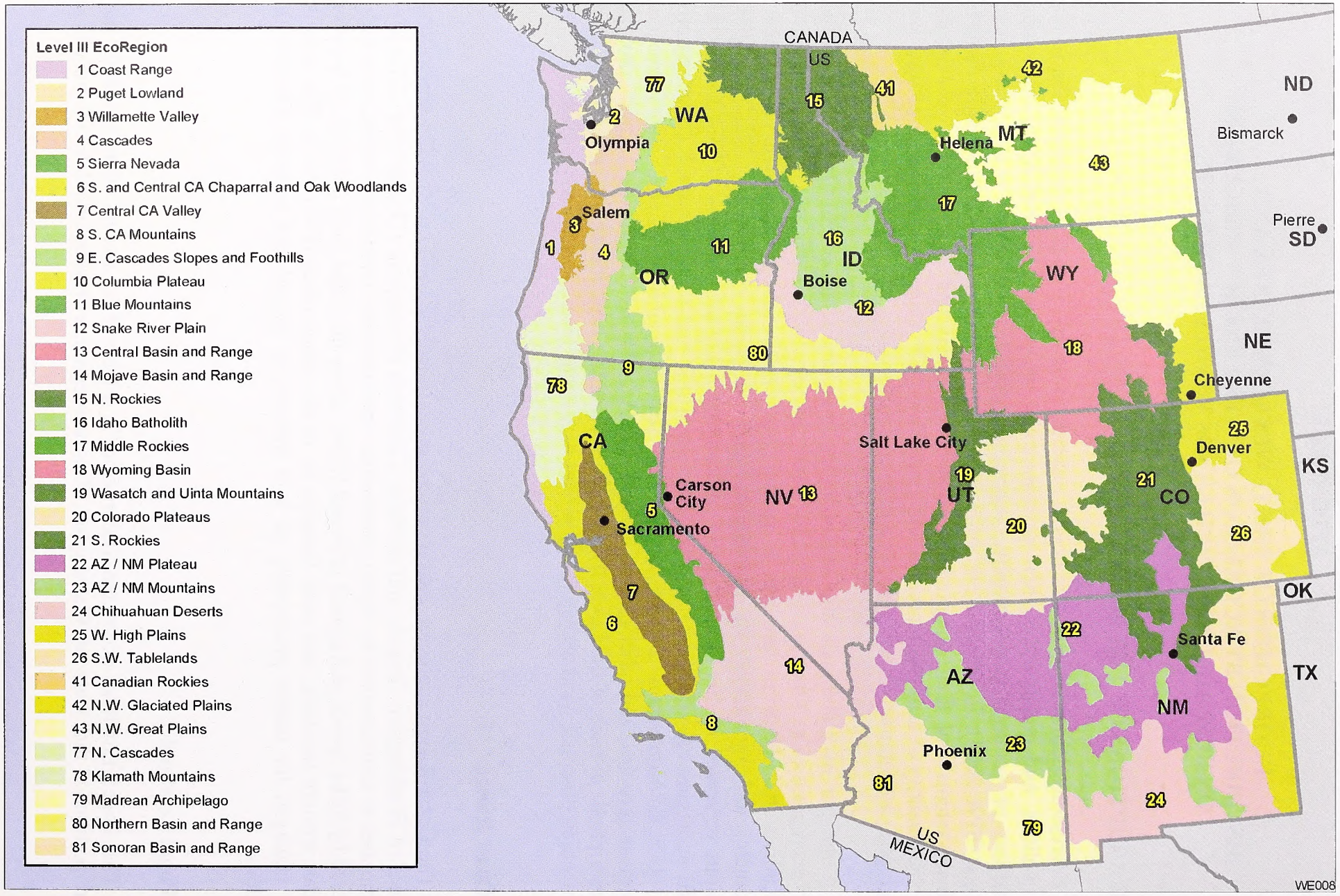


FIGURE F-1 Ecoregions of the 11 Western States (Source: EPA 2002)

broad, rolling lowland along the coastline of Puget Sound and is characterized by a maritime climate (EPA 2002). Originally supporting coniferous forests on the many ground moraines, outwash plains, floodplains, and terraces, this ecoregion now supports a mix of pasture, cropland, forests, and urban centers (Pater et al. undated).

F.1.3 Willamette Valley

The Willamette Valley ecoregion (Ecoregion 3, Figure F-1) occurs almost entirely in Oregon, with a small portion in southwestern Washington, and covers about 5,750 mi^2 (14,893 km^2) This broad, lowland valley is characterized by rolling prairies, deciduous and coniferous forests, and extensive wetlands (EPA 2002). The productive soils and temperate climate of the ecoregion make it an important agricultural region in Oregon. Most of the native plant communities have been replaced by agriculture and rural residential development, with pastureland, vineyards and tree farms, and orchards being common (University of Oregon 1999).

F.1.4 Cascades

The Cascades ecoregion occurs in portions of Washington, Oregon, and northern California (Ecoregion 4, Figure F-1), encompassing about 17,930 mi^2 (46,439 km^2). This mountainous ecoregion is characterized by steep ridges and river valleys in the west and a high plateau in the east, with both active and dormant volcanoes and elevations up to 14,403 ft (4,390 m) (EPA 2002). Its moist, temperate climate supports extensive and highly productive coniferous forests, with subalpine meadows occurring at high elevations.

F.1.5 Sierra Nevada

The Sierra Nevada ecoregion encompasses approximately 20,300 mi^2 (52,577 km^2), almost entirely in east-central California except for about 400 mi^2 (1,036 km^2) in extreme west-central Nevada (Ecoregion 5, Figure F-1). This ecoregion is a deeply dissected block fault, the eastern portion of which has been strongly glaciated but is mountainous (EPA 2002). Vegetation grades from mostly ponderosa pine at lower elevations in the west and lodgepole pine in the east, to fir and spruce at higher elevations. Alpine conditions exist at the highest elevations.

F.1.6 Southern and Central California Chaparral and Oak Woodlands

The Southern and Central California Chaparral and Oak Woodlands ecoregion encompasses about 38,650 mi^2 (100,103 km^2) entirely within California (Ecoregion 6, Figure F-1). The ecoregion exhibits a Mediterranean climate of hot, dry summers and moist, cool winters and supports mainly chaparral and oak woodlands vegetation (EPA 2002). Grasslands occur at lower elevations, and patches of pine occur at higher elevations. Most of the region is open low mountains or foothills, with some irregular plains in the south.

F.1.7 Central California Valley

The Central California Valley ecoregion occurs on about 17,750 mi^2 (45,972 km^2) completely within California (Ecoregion 7, Figure F-1). This ecoregion is a flat, intensively farmed plain that has long, hot, and dry summers and cool winters (EPA 2002). Nearly half the region is cropland, and about three-quarters is irrigated. The region once supported an array of prairies, oak-grass savannahs, desert grasslands, riparian woodlots, and wetlands. However, agricultural development, urban expansion, alteration of hydrologic regimes and channelization, grazing by domestic livestock, fires, and introduced plants and animals affected most of the native plant communities in the region (Olson and Cox 2001).

F.1.8 Southern California Mountains

The Southern California Mountains ecoregion occurs on about 6,900 mi^2 in southwestern California (Ecoregion 8, Figure F-1). This ecoregion has a Mediterranean climate of hot, dry summers and moist, cool winters (EPA 2002), but with slightly cooler temperatures and more moisture than are found in the adjacent Southern and Central California Chaparral and Oak Woodlands ecoregion. The vegetation is dominated by relatively dense chaparral and oak woodlands and also stands of ponderosa pine.

F.1.9 Eastern Cascades Slopes and Foothills

The Eastern Cascades Slopes and Foothills ecoregion is found in portions of California, Oregon, and Washington and occupies about 21,690 mi^2 (56,177 km^2) (Ecoregion 9, Figure F-1). The ecoregion is located in the rain shadow of the Cascade Mountains (EPA 2002) and has vegetation distinguished by forests of ponderosa pine, Douglas fir, and hemlock, with oak savannahs in some areas, and sagebrush and bunchgrass in upland areas (Pater et al. undated).

F.1.10 Columbia Plateau

The Columbia Plateau ecoregion, which covers about 32,100 mi^2 (83,139 km^2), occurs in portions of Idaho, Oregon, and Washington (Ecoregion 10, Figure F-1). The ecoregion is an arid sagebrush steppe and grassland, which formerly supported large expanses of native bluebunch wheatgrass, Idaho fescue, and other grasses. Much of this ecoregion has been converted to agriculture and now supports extensive wheat cultivation, with patches of shrubsteppe grassland (Noss et al., 2001; EPA 2002).

F.1.11 Blue Mountains

The Blue Mountains ecoregion occurs on 27,380 mi^2 (70,914 km^2) in Idaho, Oregon, and Washington (Ecoregion 11, Figure F-1). The native vegetation includes sagebrush steppe and

saltbrush-greasewood as well as deciduous and coniferous forest (McGrath et al. 2002; Idaho Gap Analysis Project 2004), with extensive areas of old-growth coniferous forest (DellaSalla et al. 2001) that include some of the largest stands of western juniper in the world (Oregon Progress Board 2000).

F.1.12 Snake River Plain

The Snake River Plain ecoregion is a xeric intermontane basin and range area covering about 20,700 mi^2 (53,613 km^2) in Idaho and Oregon (Ecoregion 12, Figure F-1). Crop production, cattle feedlots, and dairy operations are common in the area. Except for scattered barren lava fields, the ecoregion was dominated by sagebrush steppe vegetation that is now used for cattle grazing (McGrath et al. 2002).

F.1.13 Central Basin and Range

The Central Basin and Range is the largest ecoregion represented within the 11 western states, occurring on about 119,672 mi^2 (309,950 km^2) in California, Nevada, and Utah (Ecoregion 13, Figure F-1). This is an internally drained ecoregion characterized by a mosaic of xeric basins, scattered mountains, and salt flats (EPA 2002). Native vegetation of the ecoregion includes sagebrush grassland, saltbush-greasewood, and mountain brush, with some woodland (EPA 2002; McGrath et al. 2002). Some portions of this ecoregion are very sparsely vegetated desert, while other areas support saltbrush-greasewood, shadscale, winterfat, sagebrush, and a variety of perennial grasses and herbaceous plants (Woods et al. 2001). Juniper-pinyon woodlots and coniferous forest occur in areas of higher elevation and precipitation.

F.1.14 Mojave Basin and Range

The Mojave Basin and Range ecoregion occupies about 50,000 mi^2 (129,500 km^2) in portions of Arizona, California, Nevada, and Utah (Ecoregion 14, Figure F-1). It has a warm, temperate climate with little precipitation and includes the Mojave Desert (Holland et al. 2001; EPA 2002a). Elevations range from below sea level in Death Valley (–479 ft [–146 m]) to more than 5,249 ft (1,600 m) on some mountains (Holland et al. 2001). The ecoregion is rich in endemic ephemeral plants. Natural vegetation is dominated by mesquite, creosote bush, all-scale, brittlebush, desert holly, and sagebrush at low elevations (Holland et al. 2001); by big sagebrush, blackbrush, Mormon tea, yellowbrush, galleta, Indian ricegrass, cheatgrass, and cholla at elevations of 3,000 to 5,000 ft (940 to 1,524 m); and by pinyon, juniper, and oak woodlots at elevations of 4,000 to 7,000 ft (1,219 to 2,134 m) (Woods et al. 2001; Bryce et al. 2003).

F.1.15 Northern Rockies

The Northern Rockies ecoregion encompasses about 31,600 mi^2 (81,844 km^2) in northern Idaho, northwestern Montana, and northeastern Washington (Ecoregion 15, Figure F-1).

The high, rugged Northern Rockies ecoregion is mountainous, and, despite an inland position, its climate and vegetation are marine-influenced (EPA 2002). Douglas fir, subalpine fir, Englemann spruce, ponderosa pine, and Pacific indicators, such as western red cedar, western hemlock, and grand fir, are found in the ecoregion (McGrath et al. 2002).

F.1.16 Idaho Batholith

This ecoregion is found in central Idaho and in extreme west-central Montana. It covers about 23,750 mi^2 (61,512 km^2) (Ecoregion 16, Figure F-1). The Idaho Batholith is a dissected, partially glaciated, mountainous plateau with numerous perennial streams. Grand fir, Douglas-fir, and, at higher elevations, Engelmann spruce and subalpine fir occur. Sagebrush, bunchgrass, and Ponderosa pine grow in valley floors and deep canyons (McGrath et al. 2002).

F.1.17 Middle Rockies

The Middle Rockies ecoregion occurs on about 60,400 mi^2 (156,436 km^2) in portions of Idaho, Montana, and Wyoming (Ecoregion 17, Figure F-1). Open forest is present in this ecoregion, and foothills are partly wooded or shrub- and grass-covered. Intermontane valleys are grass- and/or shrub-covered. In Idaho, Douglas-fir, subalpine fir, lodgepole pine, Engelmann spruce, aspen, and sagebrush occur in mountain and plateau areas, while shadscale and greasewood occur in areas of low precipitation (McGrath et al. 2002).

F.1.18 Wyoming Basin

The Wyoming Basin ecoregion is found in portions of Colorado, Idaho, Montana, Utah, and Wyoming and covers about 51,470 mi^2 (133,307 km^2), mostly in Wyoming (Ecoregion 18, Figure F-1). This ecoregion is a broad intermontane basin dominated by arid grasslands and shrub lands supporting bunchgrasses and sagebrush, interrupted by high hills and low mountains (EPA 2002). Poorly drained floodplains and low terraces support sedges, rushes, cattails, and grasses. Well-drained alluvial fans and foothills support sagebrush grasslands (McGrath et al. 2002). Wetland plants occur in poorly drained floodplains, alluvial fans, and terraces (Woods et al. 2001). Much of the region is used for livestock grazing, although many areas lack sufficient vegetation to support this activity.

F.1.19 Wasatch and Uinta Mountains

The Wasatch and Uinta Mountains ecoregion occurs primarily in central Utah and extends northward into extreme southwestern Wyoming and southeast Idaho (Ecoregion 19, Figure F-1) and covers about 17,600 mi^2 (45,584 km^2). This ecoregion is composed of a core area of high, precipitous mountains with narrow crests and valleys flanked in some areas by dissected plateaus and open high mountains (EPA 2002). Middle elevations support Douglas-fir and aspen parkland; Engelmann spruce and subalpine fir occur at the highest elevations; and

alpine meadows occur at elevations above 11,000 ft (3,352 m) (Woods et al. 2001; McGrath et al. 2002). The semiarid foothills support widely spaced juniper in a sagebrush grassland.

F.1.20 Colorado Plateaus

The Colorado Plateaus ecoregion encompasses approximately 48,790 mi^2 (126,133 km^2) in Arizona, Colorado, and Utah and the extreme northwest corner (about 1 mi^2 or 3 km^2) of New Mexico (Ecoregion 20, Figure F-1). This ecoregion is typified by a rugged tableland topography, with rapid changes in local relief from 984 to 1,969 ft (300 to 600 m). The higher elevations include pinyon-juniper woodlands, while low-lying areas contain saltbrush-greasewood (typical of hotter, drier areas) (EPA 2002). The region has conspicuous but irregular vegetation zones (Primm 2001). The woodland zone is the most extensive, dominated by forests of pinyon pine and several species of juniper. Between the trees, the ground is sparsely covered by grama, other grasses, herbs, and various shrubs, such as big sagebrush and alderleaf cercocarpus.

F.1.21 Southern Rockies

The Southern Rockies ecoregion in Colorado, New Mexico, Utah, and Wyoming (Ecoregion 21, Figure F-1) covers about 55,420 mi^2 (143,538 km^2). It is at a high elevation, with steep, rugged mountains (EPA 2002). Although coniferous forests cover much of the region, the vegetation and the soil and land use follow a pattern of elevational banding. The lowest elevations are generally grass- or shrub-covered and heavily grazed. Low to middle elevations are also grazed and covered by a variety of vegetation types, including Douglas fir, ponderosa pine, aspen, and juniper oak woodlands. Middle to high elevations are largely covered by coniferous forests and have little grazing activity. The highest elevations have alpine characteristics.

F.1.22 Arizona/New Mexico Plateau

The Arizona/New Mexico Plateau encompasses about 73,900 mi^2 (191,401 km^2) in Arizona, Colorado, New Mexico, and Nevada (Ecoregion 22, Figure F-1). The ecoregion represents a large transitional region between the semiarid grasslands to the east; the drier shrublands and woodland-covered, higher-relief tablelands to the north; and the lower, hotter, less vegetated basins, ranges, and deserts to the west and south (EPA 2002). Vegetation communities include shrublands, which contain big sagebrush, rabbitbrush, and winterfat as well as shadscale saltbrush and greasewood, and grasslands that contain blue grama, wheatgrass, and needlegrass (Gallant and Omernik 1989). Higher elevations may support pinyon pine and juniper forests.

F.1.23 Arizona/New Mexico Mountains

The Arizona/New Mexico Mountains ecoregion covers about 41,870 mi^2 (108,443 km^2) of Arizona and New Mexico (Ecoregion 23, Figure F-1). It is distinguished from neighboring mountainous ecoregions by its lower elevations and an associated vegetation indicative of drier, warmer environments. Forests of spruce, fir, and Douglas fir are found only in a few high-elevation parts of this region. Chaparral is common on the lower elevations; pinyon-juniper and oak woodlands are found on the lower and middle elevations; and open to dense ponderosa pine forests occur at higher elevations (EPA 2002).

F.1.24 Chihuahuan Deserts

The Chihuahuan Deserts ecoregion covers about 29,300 mi^2 (75,887 km^2) of southern Arizona and New Mexico (Ecoregion 24, Figure F-1). The ecoregion consists of broad basins and valleys bordered by sloping alluvial fans and terraces. Isolated mesas and mountains are located in the central and western parts of the region. Vegetative cover is predominantly arid grass and shrubland, except on the higher mountains, where oak-juniper woodlands occur (EPA 2002).

F.1.25 Western High Plains

The Western High Plains ecoregion (Ecoregion 25, Figure F-1) occurs in the eastern portions of Colorado, New Mexico, and Wyoming as well as the western portions of Texas, Oklahoma, Kansas, and Nebraska. It consists of smooth to slightly irregular plains that have a high percentage of cropland (EPA 2002a). In the three states of Colorado, New Mexico, and Wyoming, this ecoregion covers about 40,953 mi^2 (106,068 km^2) and includes the second-largest grassland ecoregion in North America (Cook et al. 2001). Grama and buffalo grass dominate the natural vegetation in this region, which includes grama-buffalo grass prairie, bluestem-grama prairie, sandsage-bluestem prairie, and wheatgrass-bluestem-needlegrass prairie.

F.1.26 Southwestern Tablelands

The Southwestern Tablelands ecoregion encompasses about 35,660 mi^2 (92,359 km^2) of south-central Colorado and northeastern New Mexico (Ecoregion 26, Figure F-1). The ecoregion is a subhumid grassland and semiarid rangeland (EPA 2002). The natural vegetation in this ecoregion is grama-buffalo grass, with some mesquite-buffalo grass in the southeast, and with midgrass prairie and open and low shrubs along the Canadian River.

F.1.27 Canadian Rockies

The Canadian Rockies ecoregion encompasses about 7,270 mi^2 (18,829 km^2) in northwest Montana (Ecoregion 41, Figure F-1) only. Most of the ecoregion, however, is located

in Canada (EPA 2002). At lower elevations, the vegetation is mostly Douglas fir, spruce, and lodgepole pine; alpine fir occurs at middle elevations; and treeless alpine habitats occur at the higher elevations.

F.1.28 Northwestern Glaciated Plains

The Northwestern Glaciated Plains ecoregion (Ecoregion 42, Figure F-1) is a transitional region between the generally more level, moister, more agricultural Northern Glaciated Plains ecoregion to the east and the generally more irregular and drier Northwestern Great Plains ecoregion to the west and southwest (EPA 2002). Of the 11 western states, Montana is the only one in which this ecoregion occurs, where it encompasses about 37,000 mi^2 (95,830 km^2) in the north-central and northeastern portions of the state. Vegetation of this ecoregion is primarily grass, such as grama, wheatgrass, and needlegrass, with areas of shortgrass prairie and sagebrush steppe (EPA 2002). Portions of this ecoregion include a moderately high concentration of semipermanent and seasonal wetlands, locally referred to as prairie potholes.

F.1.29 Northwestern Great Plains

The Northwestern Great Plains ecoregion (Ecoregion 43, Figure F-1) covers about 77,900 mi^2 (201,761 km^2) in Montana and Wyoming. It also occurs in portions of Nebraska and the Dakotas. The ecoregion, which is part of the largest grassland area in North America (Primm et al. 2001), is a semiarid, rolling plain with erratic precipitation (EPA 2002). Native grasslands, largely replaced on level ground by spring wheat and alfalfa, persist in rangeland areas on broken topography. The dominant grass communities include grama-needlegrass and wheatgrass, and wheatgrass-needlegrass (Primm et al. 2001). A variety of shrubs and herbs also occur, with sagebrush being most abundant.

F.1.30 North Cascades

The North Cascades ecoregion encompasses about 11,700 mi^2 (30,303 km^2) in northwest Washington (Ecoregion 77, Figure F-1). It also encompasses portions of Canada. The terrain of this ecoregion is composed of high, rugged mountains (EPA 2002). This ecoregion contains the greatest concentration of active alpine glaciers in the conterminous United States and has a variety of climatic zones. Forest communities at higher elevations support Engelmann spruce, subalpine fir, lodgepole pine, white spruce, Douglas fir, and quaking aspen (Kavanagh and Sims 2001). The lowest elevations in the eastern portions of the ecoregion contain parkland of scattered ponderosa pine in a matrix of bluebunch wheatgrass and sagebrush.

F.1.31 Klamath Mountains

The Klamath Mountains ecoregion occurs in north-central California and south-central Oregon, on about 18,700 mi^2 (48,433 km^2) (Ecoregion 78, Figure F-1). The ecoregion is

physically and biologically diverse (EPA 2002), with highly dissected, folded mountains, foothills, terraces, and floodplains. The mild, subhumid climate of the Klamath Mountains ecoregion is characterized by a lengthy summer drought and supports diverse vegetation, including chaparral and mixed conifer forests with oak woods, Douglas-fir, Ponderosa pine, and grasslands with bunchgrass and wheatgrass (Thorson et al. 2003).

F.1.32 Madrean Archipelago

The Madrean Archipelago ecoregion encompasses about 16,100 mi^2 (41,699 km^2) in the southern portions of Arizona and New Mexico (Ecoregion 79, Figure F-1). It consists of basins and ranges with medium to high local relief, typically 3,281 to 4,921 ft (1,000 to 1,500 m) (EPA 2002). Native vegetation in the region is mostly grama-tobosa shrubsteppe in the basins and oak-juniper woodlands on the ranges, except at higher elevations, where ponderosa pine is predominant.

F.1.33 Northern Basin and Range

The Northern Basin and Range ecoregion occupies about 54,905 mi^2 (142,204 km^2) in portions of California, Idaho, Nevada, Oregon, and Utah (Ecoregion 80, Figure F-1). This ecoregion contains arid tablelands, intermontane basins, dissected lava plains, and scattered mountains (EPA 2002). Nonmountainous areas have sagebrush grassland or saltbrush greasewood steppe vegetation, with cool-season grasses being common (McGrath et al. 2002; EPA 2002). The ranges in this ecoregion are generally covered in Mountain sagebrush, mountain brush, and Idaho fescue at lower and middle elevations. Douglas-fir and aspen are common at higher elevations (Woods et al. 2001; Bryce et al. 2003). Valleys within the ecoregion support sagebrush steppe or saltbush vegetation; and juniper woodlands occur on rugged, stony uplands. Portions of this ecoregion are used as rangeland; some areas are used for cropland (Thorson et al. 2003).

F.1.34 Sonoran Basin and Range

The Sonoran Basin and Range ecoregion encompasses about 45,100 mi^2 (116,809 km^2) of southern Arizona, California, and New Mexico (Ecoregion 81, Figure F-1). This ecoregion contains scattered low mountains and large areas of palo verde-cactus shrub and giant saguaro cactus (EPA 2002).

F.2 DISTRIBUTION OF WIND ENERGY RESOURCES

This PEIS evaluates the potential ecological impacts of wind energy development on BLM-administered lands in the western United States. To do so, it examines the distribution of potential wind energy development across Level III ecoregions within each of the states. Figures F-2 through F-11, which appear at the end of this appendix after the references, depict

the in-state distribution of BLM-administered lands that have been determined to exhibit a medium to high potential to support wind energy development, by ecoregion.

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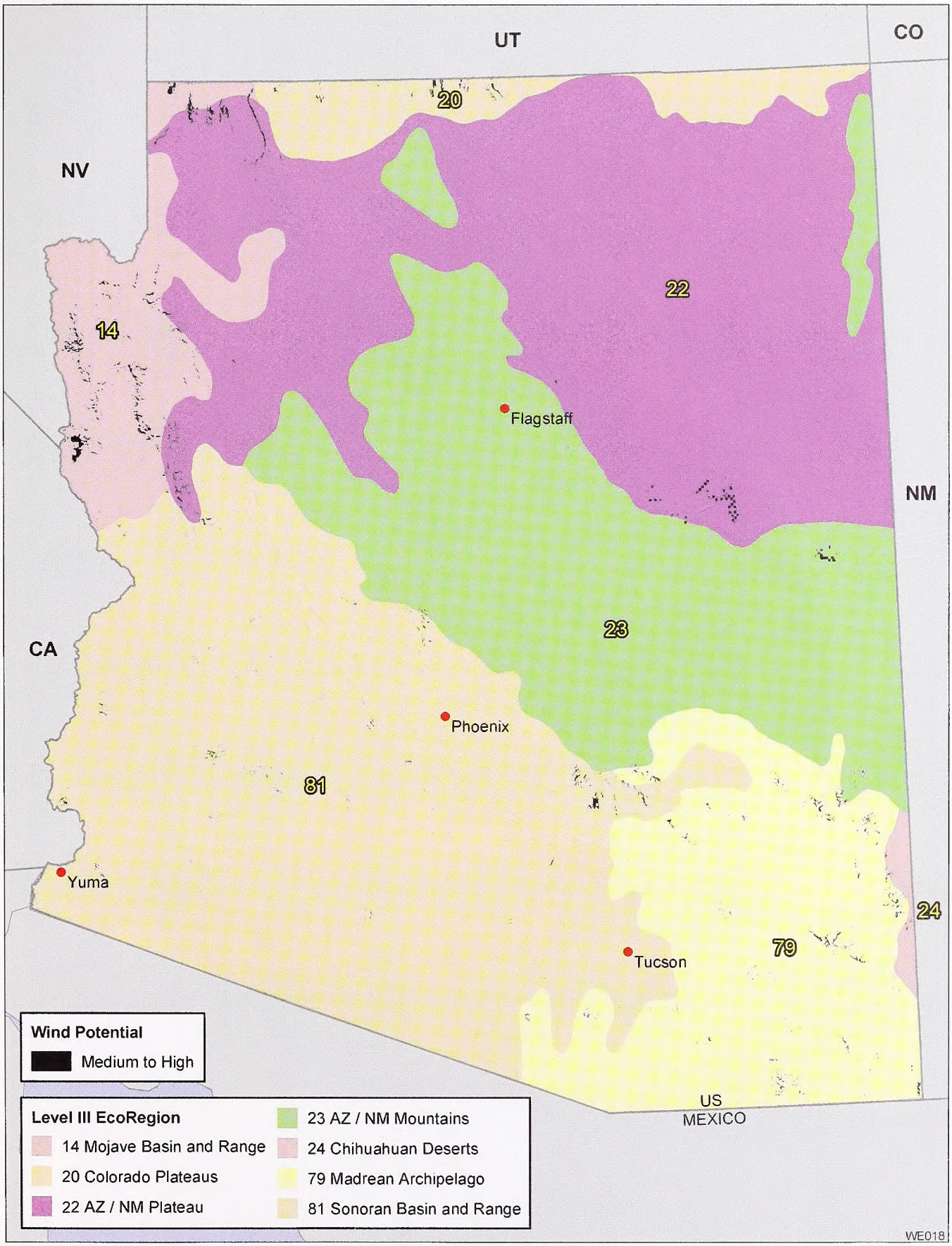


FIGURE F-2 Distribution of BLM-Administered Lands with Medium to High Wind Potential across Ecoregions in Arizona

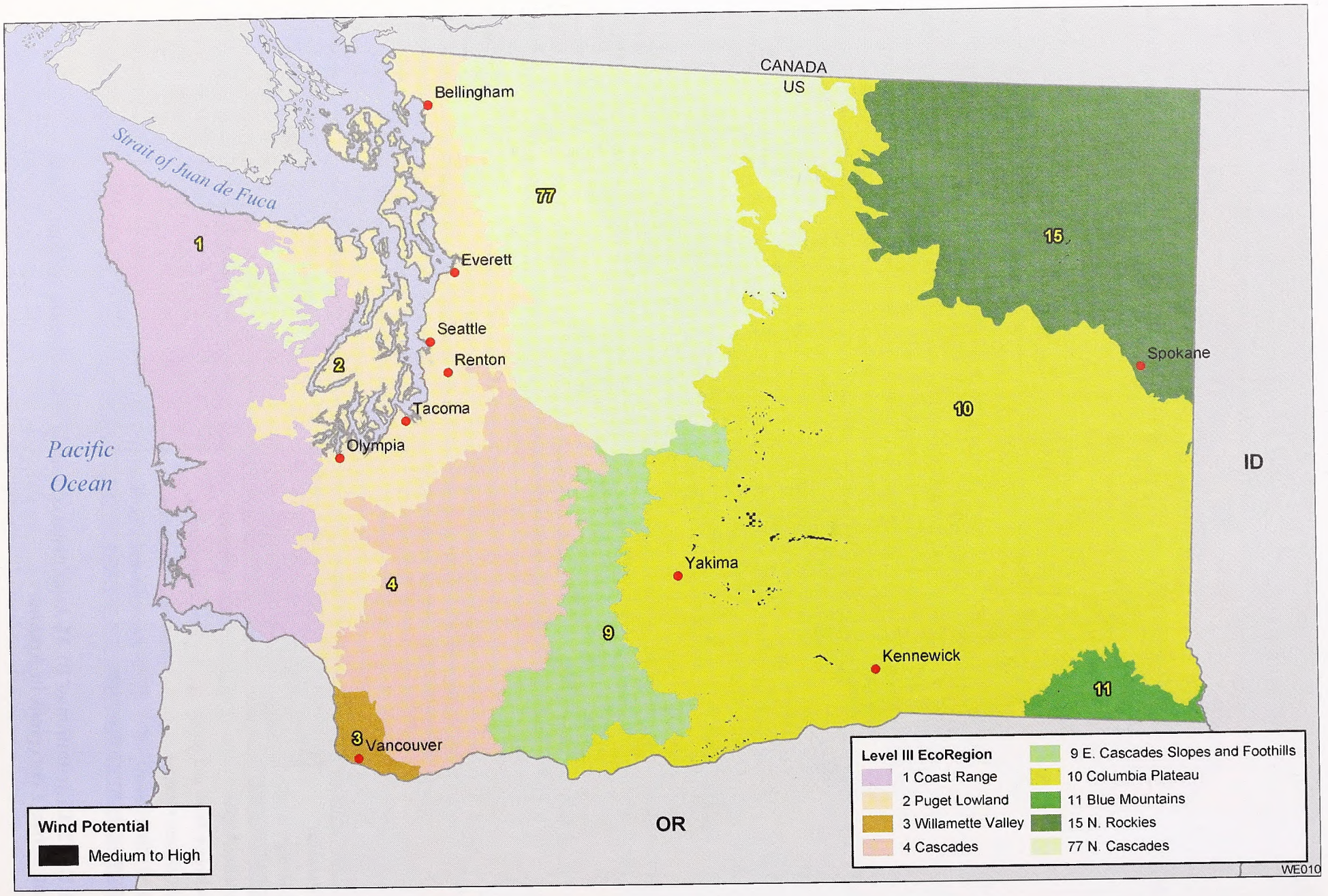


FIGURE F-3 Distribution of BLM-Administered Lands with Medium to High Wind Potential across Ecoregions in Washington

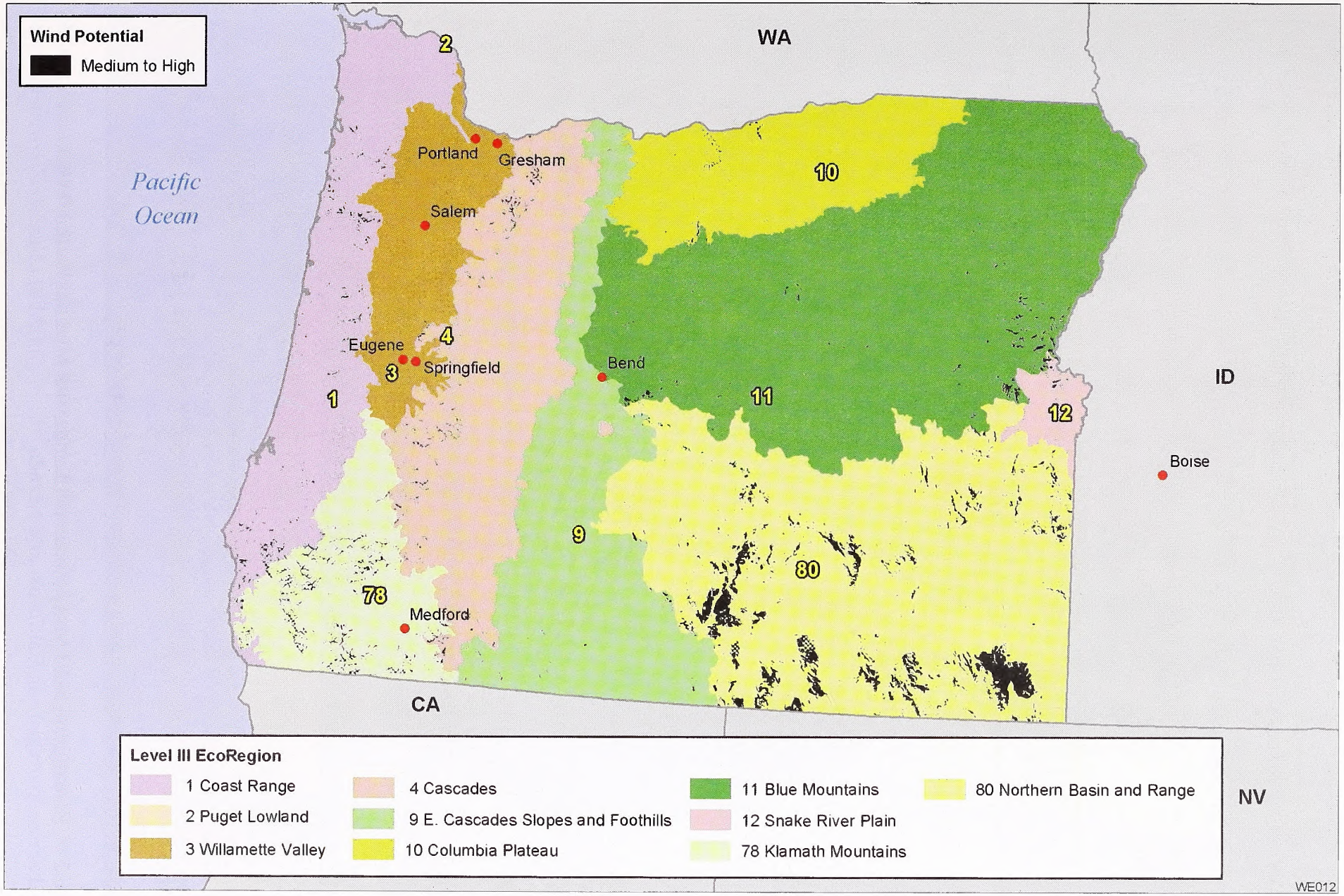


FIGURE F-4 Distribution of BLM-Administered Lands with Medium to High Wind Potential across Ecoregions in Oregon

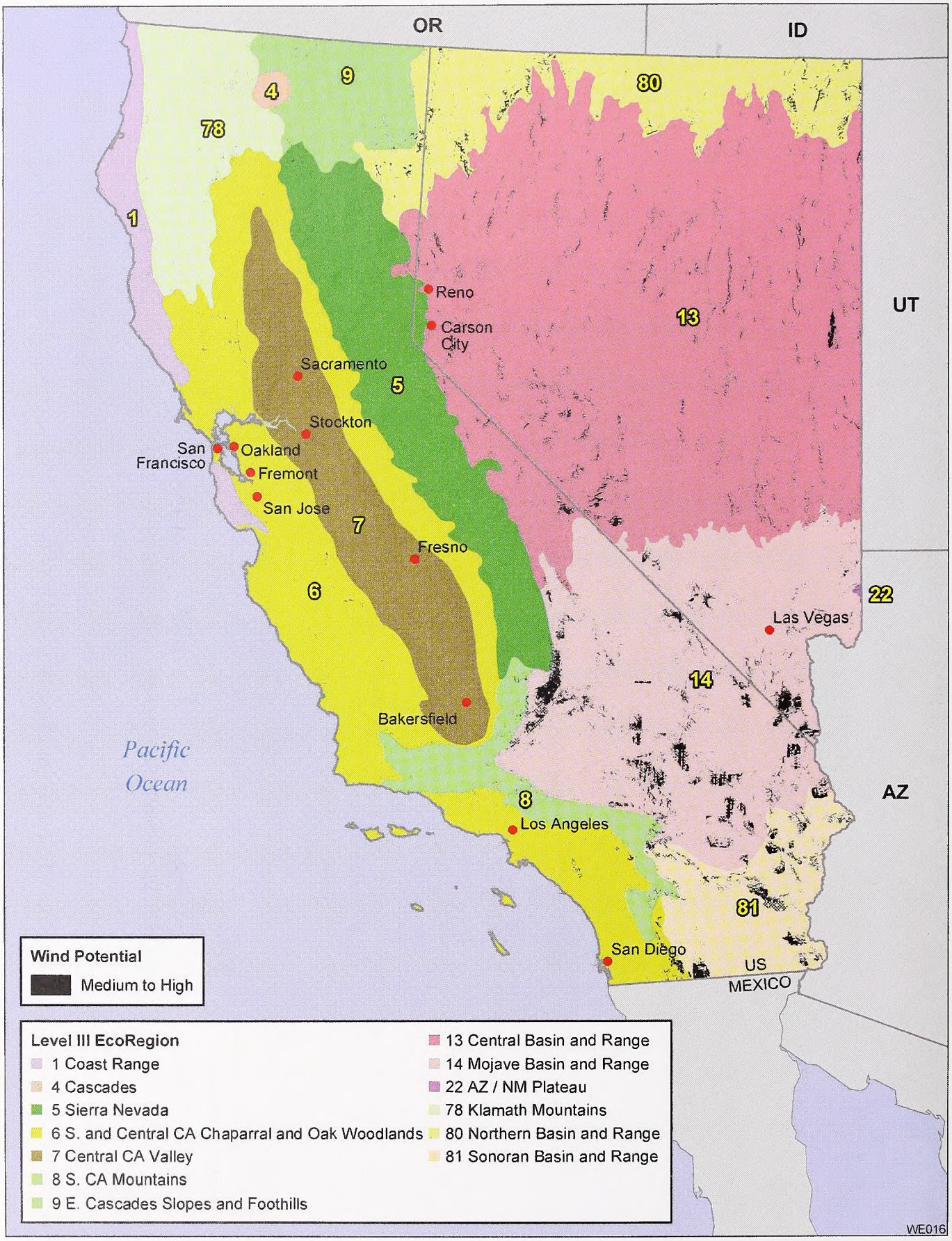


FIGURE F-5 Distribution of BLM-Administered Lands with Medium to High Wind Potential across Ecoregions in California and Nevada

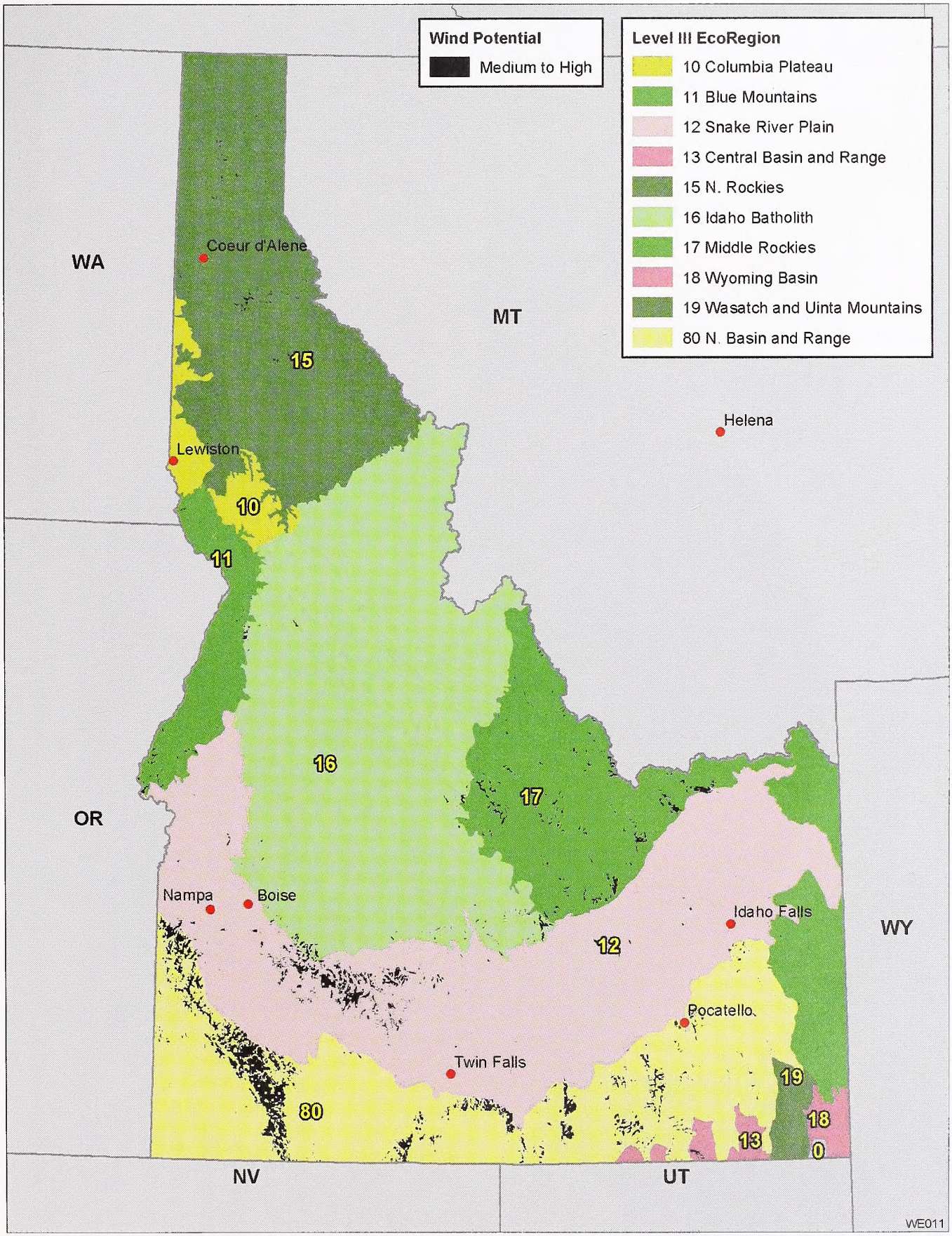


FIGURE F-6 Distribution of BLM-Administered Lands with Medium to High Wind Potential across Ecoregions in Idaho

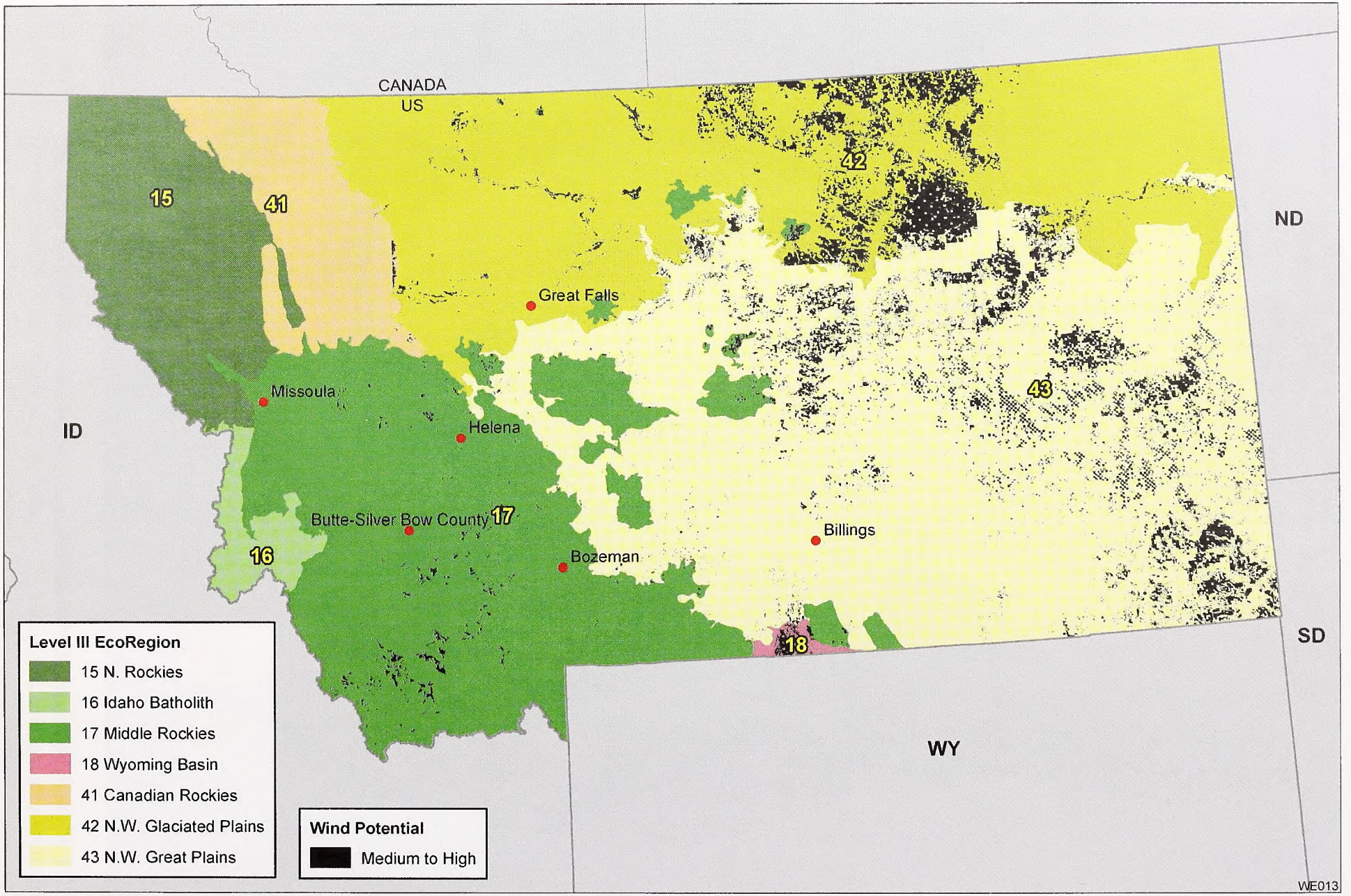


FIGURE F-7 Distribution of BLM-Administered Lands with Medium to High Wind Potential across Ecoregions in Montana

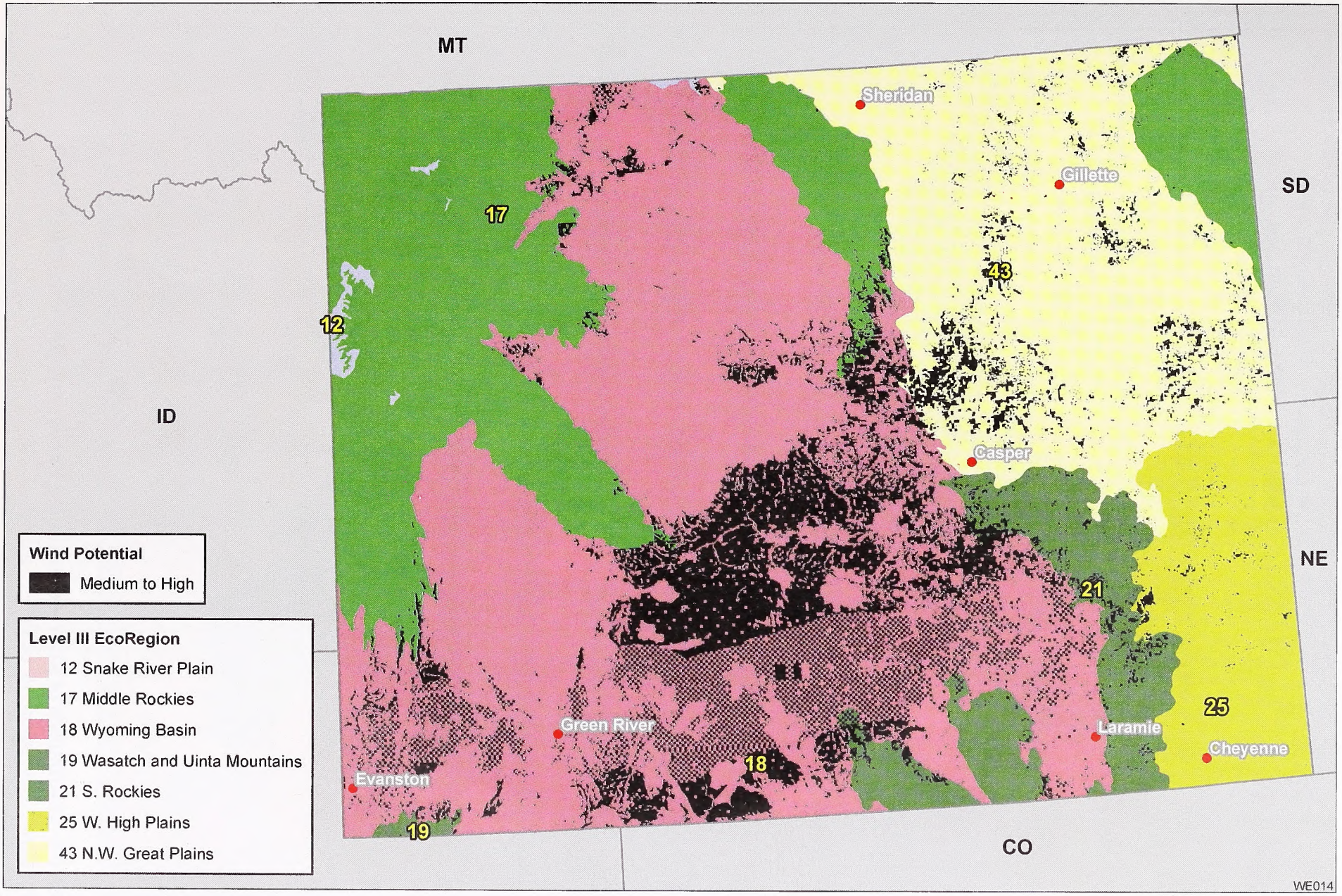


FIGURE F-8 Distribution of BLM-Administered Lands with Medium to High Wind Potential across Ecoregions in Wyoming

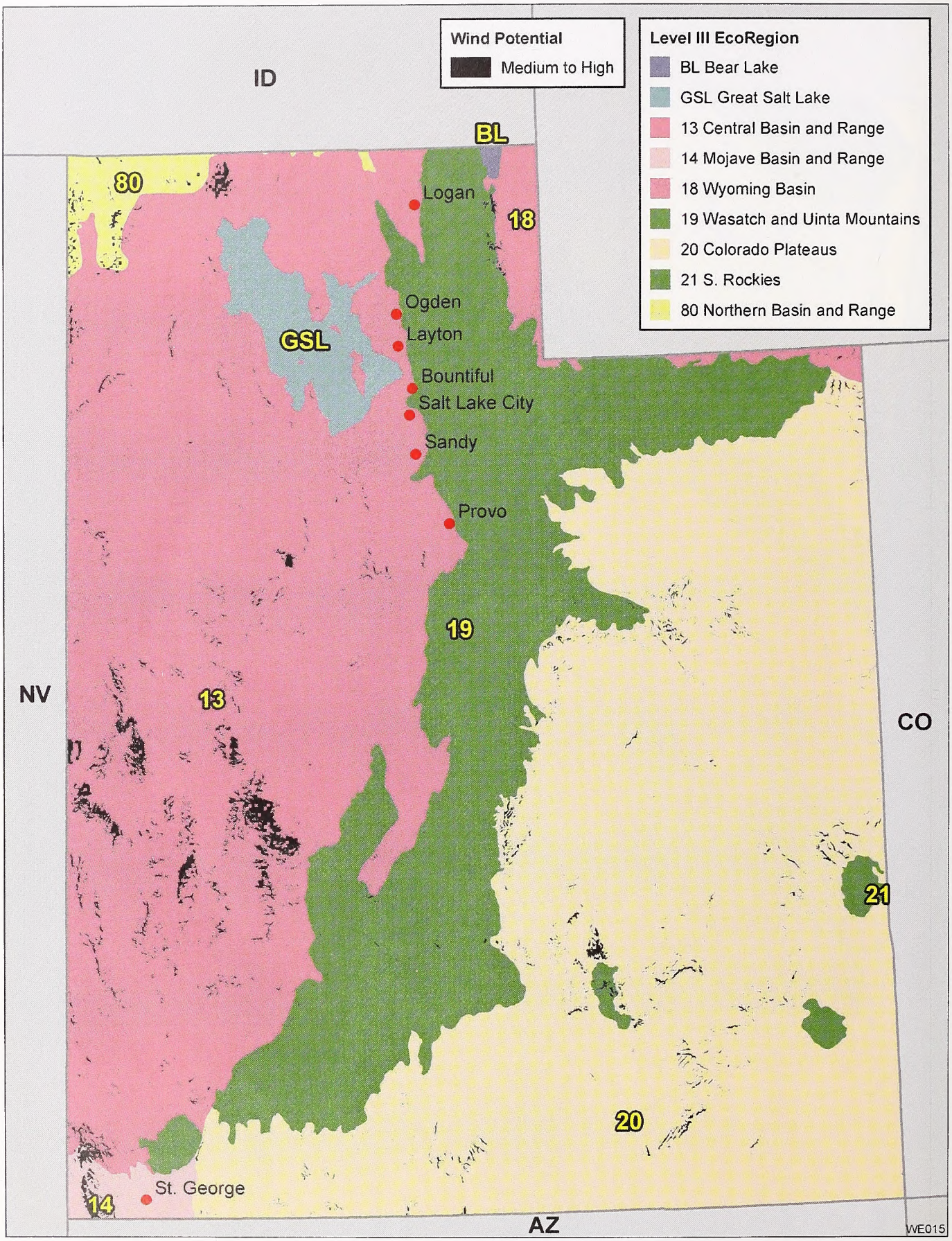


FIGURE F-9 Distribution of BLM-Administered Lands with Medium to High Wind Potential across Ecoregions in Utah

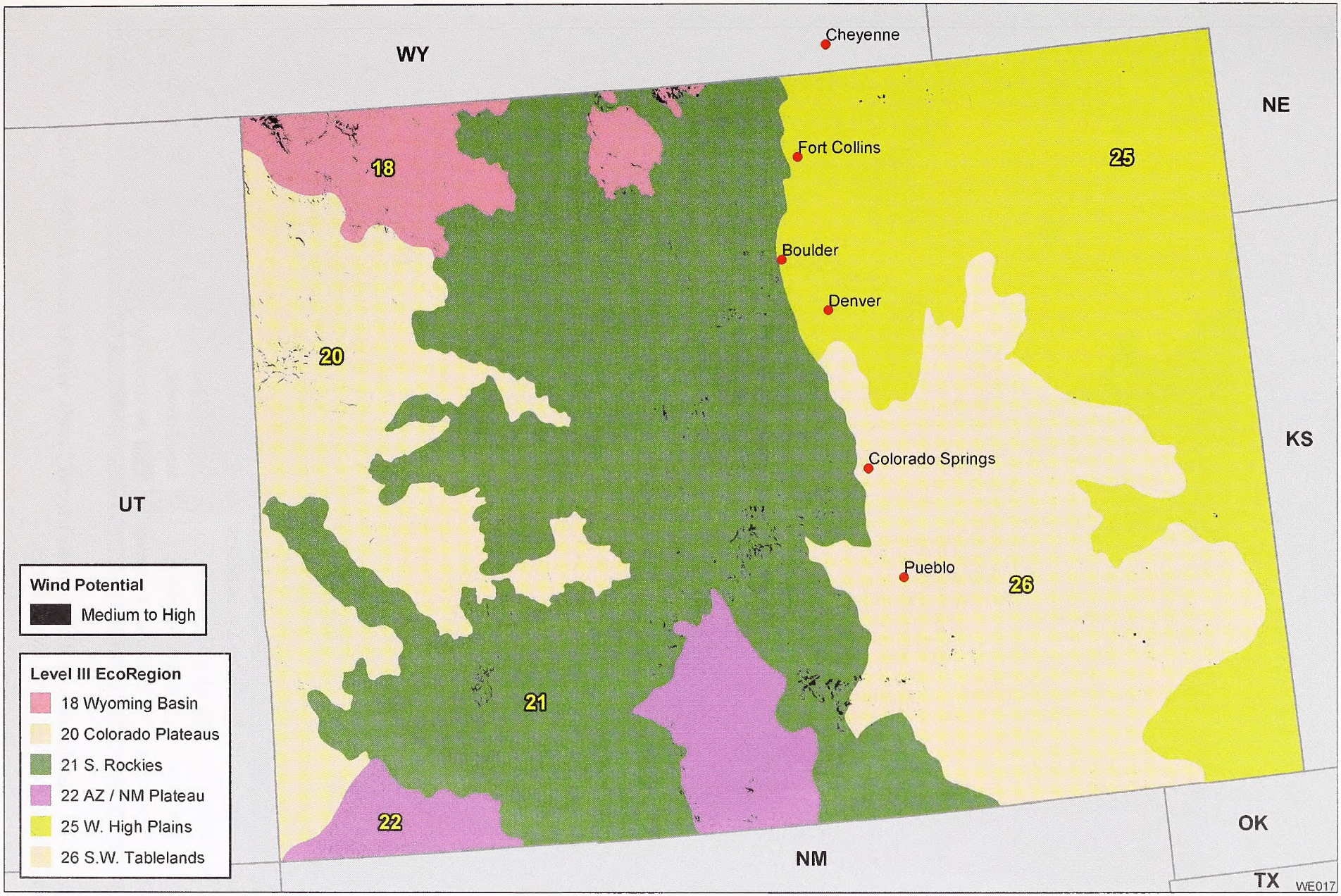


FIGURE F-10 Distribution of BLM-Administered Lands with Medium to High Wind Potential across Ecoregions in Colorado

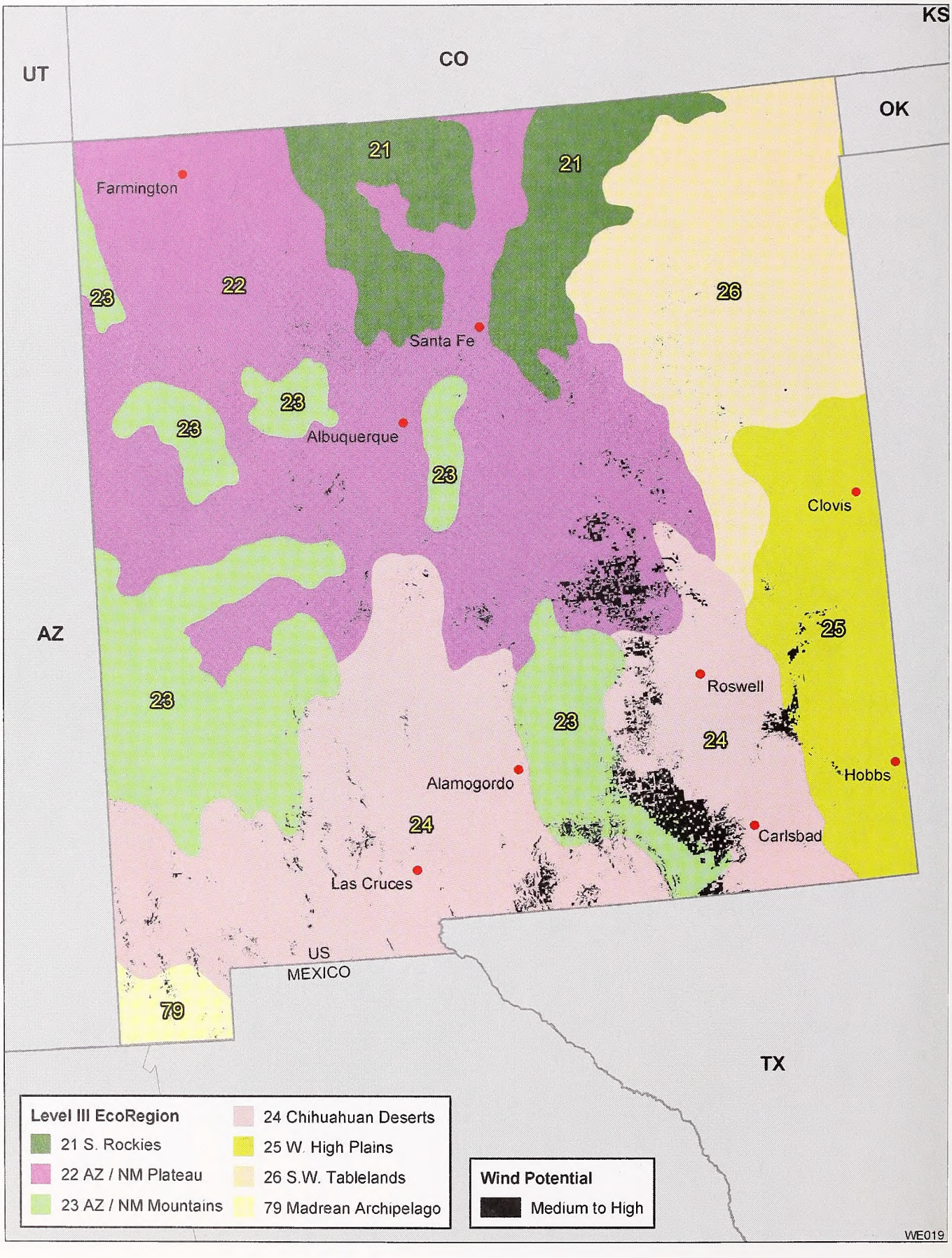


FIGURE F-11 Distribution of BLM-Administered Lands with Medium to High Wind Potential across Ecoregions in New Mexico

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